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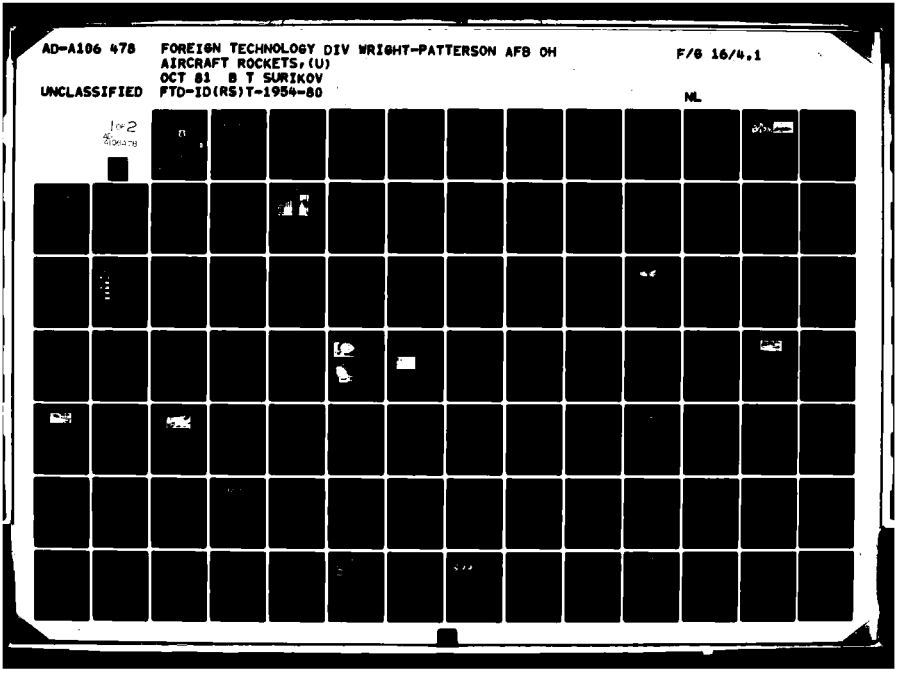

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FOREIGN TECHNOLOGY DIVISION

AIRCRAFT ROCKETS

by

B. T. Surikov

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
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И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
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М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yë or ë.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

AIRCRAFT ROCKETS.

B. T. Surikov.

Page 2.

The pamphlet "Aircraft rockets" enters into the produced by military publishing house library "Rocket engineering". In it are given the general information about the tactical-technical characteristics and the design features of aircraft rocket armament, and is also presented the essence of the phenomena, which occur during missile targeting to air and ground targets. Are examined questions of the combat use of an aircraft rocket weapon.

Pamphlet is intended for the soldiers and the sergeants, connected with the operation and the combat use of aircraft rocket armament. It also can be it is useful all desiring to be introduced to this armament.

Work is written based on materials of the open press/printing; all data about the rockets and their combat employment are undertaken from the foreign press.

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Chapter I.

AIRCRAFT ROCKET WEAPON OF CLASS AIR-TO-AIR.

In the course of the Second World War was established/installed the insufficient effectiveness of fighter aviation against the night bombers. This was explained by the low accuracy of the ground radar of induction/guidance and by the absence on board the fighter of the special radar sights, which ensure the approach of interceptor for the target in the clouds and at night.

At present abroad in fighter aviation wide distribution received the all-weather fighter-interceptors, equipped by instruments for the search for air enemy and conduct with it of combat at night, also, under severe weather conditions out of the visibility of target.

The rifle armament of fighter aviation - the aircraft machine guns and of gun - in recent years began to be displaced by those not guided, and then those controlled, with air-to-air missiles.

Most important the advantage of rocket weapon consists in the

fact that it can be equipped with a considerably larger quantity of explosive, than the projectiles of aircraft cannons. Furthermore, the controlled air-to-air missiles possess the high precision/accuracy of induction/guidance, which raises the probability of the destruction of the aerial targets.

Fundamental characteristics of the unguided and controlled air-to-air missiles.

The unguided air-to-air missiles, or the so-called air-to-air missiles, have simple device/equipment.

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They consist of the following basic elements/cells: housing with the solid propellent rocket engine and warhead with the fuse.

Missile body is manufactured from the durable metal and has well streamlined shape. The nose section of the rocket is always sharpened, and middle and tail pieces are the elongated cylinder. For decreasing the drag the diameter of housing must be minimum possible.

The stabilization of the unguided rockets in flight is accomplished/realized with the aid of the special tail assembly,

fixed to the aft body.

Warhead is intended for the damage/defeat of the aerial targets. In the unguided rockets it is usually explosive or fragmentation; however, sometimes is applied atomic head.

The blast effect of warhead is based on the destruction of target by the air wave which with an increase in altitude (with the decrease of air density) weakens. The fragmentation effect of warhead does not depend on flight altitude of target, since it is based on the mechanical decomposition of the vital elements/cells of the aircraft of enemy by the fragments, which were being formed during the explosion of charge.

In connection with the fact that the probability of the direct hit of the unguided rocket into the aerial target is insignificant, the blasting/detriment of its warhead is produced in immediate proximity of the target with the aid of the proximity fuse, based on the electromagnetic, the photoelectric, the acoustic or other principles.

In spite of the relatively simple device/equipment of the unguided air-to-air missiles, they possess sufficiently high effectiveness.

For example, the American unguided rocket "Mighty Mouse" bore 70 mm can be started on the target from the distance to 2 km and more. Under these conditions the required kill probability of target is provided by the salvo fire, with which simultaneously start 12 (24) rockets (Fig. 1).

Rockets "Mighty Mouse" are installed on the fighter in the special cassette which can be advanced completely for the launching of all 12 (24) rockets. Besides extensible cassette, in some fighters are installed for the rockets the external streamlined containers, which are fastened under the wing or to the wing tips.

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Preliminary guidance to the target of the fighter, armed by the unguided rockets of the type "Mighty Mouse", usually is accomplished/realized with the aid of the ground radar, and approach to initial position for the attack and aimings - with the aid of the radar sight. Targets often are intercepted in the intersecting or randomly intersected courses.

The unguided rockets are sometimes equipped not with usual, but atomic warheads. In the USA is created the rocket "Genie", in which is used the atomic head in power 2 kt (Fig. 2).

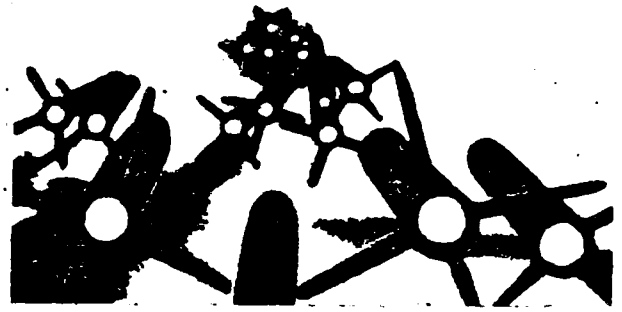

Fig. 1.

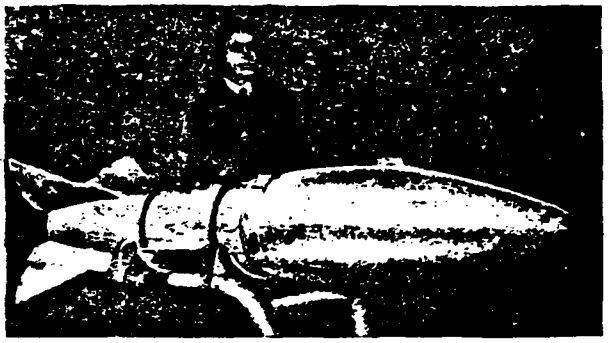

Fig. 2.

Fig. 1. Unguided air-to-air missiles in flight.

Fig. 2. Unguided rocket "Genie", equipped with atomic warhead.

It can strike air ones at the distance 2.4 km. The rocket "Genie" weighs 450 kg and has the length of 2.4 m, a diameter of housing 0.37 m, a span of wings 0.6 m. On the rocket is established/installed the solid propellant engine.

According to the communications/reports to the foreign press, the tests of this weapon conducted confirmed the possibility of applying the atomic charges in the air-to-air missiles.

With an increase in the velocities of combat aviation sharply were raised the requirements for the precision/accuracy of the firing air-to-air missiles. Main disadvantage in the unguided air-to-air missiles is the impossibility to correct their attitude in the period of approach for the target. This fact caused appearance of the guided missiles, which possess the high precision/accuracy of firing. The controlled air-to-air missiles have relatively low weight and can strike the aerial targets, which fly by several kilometers of higher than the fighter-interceptor, with the aid of the usual and atomic warheads.

Shortcomings in the unguided and controlled air-to-air missiles include the difficulty of their arrangement/position on the aircraft and reduction/descent in the aircraft performance. In the foreign press it was repeatedly noted that the guided missiles yet do not possess the necessary operational reliability.

Fig. 3 shows simplified diagram of the controlled air-to-air missile. Characteristic design feature of similar flight vehicles is the wide application in them of solid propellant engines which accelerate/disperse rocket to the speed, several times which exceeds the speed of sound.

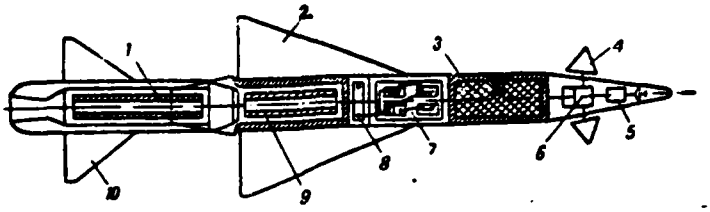

Fig. 3. The design concept of the controlled air-to-air missile: 1 - booster engine; 2 - wing; 3 - warhead and fuse; 4 - control; 5 - homing coordinator; 6 - drive of control; 7 - control bay; 8 - storage battery/accumulator; 9 - sustainer engine; 10 - the lifting surface of the rejected part of the projectile.

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The controlled air-to-air missile is strongly elongated fusiform body to which are fastened small wings and controls. Controls are intended for the rotations of rocket around the center of gravity, and wings create the part of lift. For the manufacture of the housings and the wings, and also the load-bearing elements of rocket apply durable aluminum and magnesium alloys, steel of the highest types and different plastics. In missile production considerable attention is paid to the miniaturization of all units and elements/cells, including bolts and pins.

Structurally/constructionally missile body consists of several

sections which are intended for positioning/arranging the solid propellant engine, equipment of control and warhead with the proximity fuse.

On the guided missiles the engine and warhead accomplish the same tasks, as on those not guided. The new, important element/cell of this weapon is equipment for control which makes it possible to accurately aim rocket at the target, in spite of possible sighting errors and maneuvering of the aircraft of enemy.

For missile targeting utilize different control systems. Sufficiently wide acceptance received the homing system, which performs the approach of rocket for the target without the participation of onboard equipment of aircraft. There are also rockets for induction/guidance of which is applied the equipment for control, placed both on the aircraft and on rockets themselves.

The typical sample/specimen of the controlled rocket weapon of fighter aviation it is possible to consider the sufficiently portable American rocket "Falcon", which with the limited weight and the small dimensions can be started about to the aerial targets from the distance to 8 km. Length of rocket "Falcon" about 2 m, diameter of housing 0.16 m, span of wing 0.5 m, weight of approximately 50 kg.

Rocket has several modifications, which are characterized by self-homing heads (thermal, radar).

Besides self-homing head, into the assembly of onbcard equipment enter small/miniature autopilct, computer, the warhead and the sclid propellant engine, which is frequently called solid propellant engine.

With rockets "Falcon" arm the subsonic and supersonic all-weather interceptcrs, equipped by spacial fire ccntrol systam.

Page 8.

After the preliminary output cf these fighters from the earth/ground into target area with the aid of the fire control system is perfcrmed search, detection, the "capture/grip" of target and the firing at it by rockets.

In the press/printing it was communicated that each fighter-interceptor is usually armed with different samples/specimens cf the rockets "Falcon", part from which is guided tc the target with the aid of the infrared ones cr the thermal ones, and part - with the aid of the radar homers (Fig. 4).

Infrared homing head is established/installed also on the American rocket "Sidewinder", with which are armed the fighters of PVO [Air Defense] and the navy of the USA (Fig. 5).

This rocket is carried out on the so-called aerodynamic configuration of "canard", i.e., its control vanes are placed in the forward section, and cruciform tapered wings - at the end of the housing.

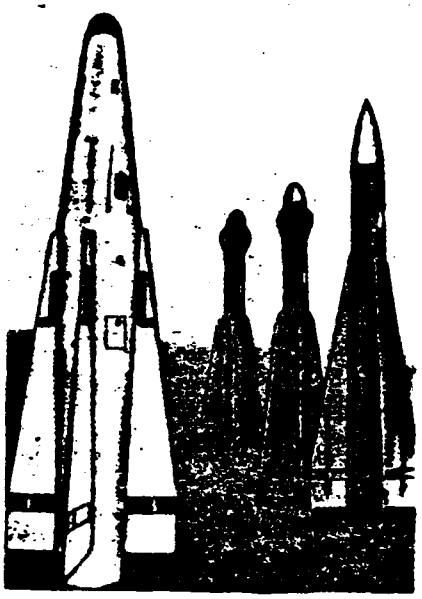

Fig. 4.

Fig. 5.

Fig. 4. Appearance of different modifications of air-to-air missiles "Falcon".

Fig. 5. Appearance of air-to-air missile "Sidewinder".

Missile-firing distance 5.5 km, overall length of approximately 3 m, diameter of 0.11 m, over-fins diameter 0.7 m, warhead HE fragmentation. Warhead weighs 22 kg, and entire rocket - 70 kg.

Rocket "Sidewinder" is simple in the operation and does not require complicated starting equipment. It possesses high maneuverability. Search head begins to work from the moment/torque of start. Homing range under clear weather conditions at the high altitudes of approximately 5 Km, and at the level of sea of approximately 1 km.

The search head of homing system is established/installed in the nose section of rocket, after it is placed remaining equipment for control. In the section, which is located about the controls, place the servodrives, which are connected with the controls. Warhead is placed after the steering section, and engine - in the middle and tail sections of the rocket.

Sometimes for the induction/guidance of air-to-air missiles apply the combined guidance systems. For example, on the American rocket "Sparrow-III" in the first seconds of flight control is accomplished/realized with the aid of aircraft electronic equipment, and further approach for the target is performed with the aid of the radar homer.

"Sparrow-III" can strike the aerial targets with the HE

fragmentation charge from the distance 10-12 km. Toward the end of the work of solid propellant engine this rocket, and majority of similar flight vehicles, is accelerated/dispersed to the speed, which exceeds the speed of sound 2.5-3 times (2.5-3 M). Essential shortcoming in the rocket - unwieldiness and large weight (the overall length of 3.6 m, the span of the wings of approximately/exemplarily 1 m, the diameter of 0.22 m, the weight of 173 kg).

Englishmen also equip their fighter-interceptors with the controlled air-to-air missiles.

For the high-altitude fighter-interceptors are created 136-kg rocket "Firestreak", which can strike the aerial targets from the distance 7 km. Rocket develops the speed, which exceeds the speed of sound 2-2.5 times. "Firestreak" has the large sizes/dimensions (with the diameter of housing of approximately 0.2 m its length exceeds 3 m).

In France, Canada, Western Germany, Italy and other capitalist states also is conducted considerable work on the equipment of fighter-interceptors with contemporary rocket weapon.

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All samples/specimens of air-to-air missiles have identical with respect to their designation/purpose elements/cells. They are characterized in terms of aerodynamic configurations and the construction/design of separate units.

Aerodynamic configurations of air-to-air missiles.

Air-to-air missiles are the supersonic well streamlined flight vehicles. They have thin cigar-shaped form for decreasing the drag.

The unguided air-to-air missiles do not have wings, but for the stabilization in flight at the end of the housing are established/installed fixed stabilizers. Housing is the load-bearing element, which connects up unit warhead, engine and stabilizers.

Stabilizers are established, as a rule, on all types of air-to-air missiles. On the unguided rocket "Mighty Mouse" are used the folding horizontal and vertical fins. This construction/design

simplified their arrangement/position in the cassettes.

The most important element/cell of the guided missiles are wings and air vanes. Wings create the part of the lift, utilized during the motion of rocket along the trajectory of induction/guidance. Air vanes are the final control elements and are intended for accomplishing the necessary maneuvering in the process of the guidance of rocket to the target.

Wings in the plan/layout can have various forms: rectangular, trapezoidal, triangular. In the cross section as the ideal supersonic wing profile is considered even plate; however, it cannot maintain considerable g-forces; therefore on the rockets are been commonly used wings with the symmetrical biconvex profiles.

In the air-to-air missiles sufficiently wide distribution received the construction/design, shown in Fig. 6. The aerodynamic configuration of rocket consists of two mutually perpendicular wings, placed approximately of the center of gravity of housing, and two surfaces of the tail assembly which are arranged/located after the wings and can be with them in one plane or compose angle in 45° (normal diagram).

Elevators are utilized for steering of rocket along the height/altitude, while rudders - in the direction. The elevators and rotation are fastened to the external trailing edge of stabilizers. Besides controls, are applied the ailerons, which are established on the trailing wing edges and serve for imparting to rocket torque. There are also other constructions/designs of controls. For example, the surfaces of the tail assembly sometimes make with rotary ones, thanks to which they accomplish the same tasks, that elevators, rudders and ailerons.

In the rockets, made on the aerodynamic configuration of "weft", mobile controls are arranged/located in front of the main wing. Theoretically this diagram has certain advantage before the normal diagram. It consists in the fact that the lift, created by controls, acts in the same direction, as gross lift. However, in this diagram deteriorates the flow around of the wing of air flow.

In the rockets, which have cruciform wing arrangement and controls, rotation of controls around two main mutually perpendicular control planes it is fulfilled by usually independent variable from each other. In such constructions/designs is always accomplished/realized a strict stabilization of rocket along the

bank, so that one wing would be located in the vertical plane, and another - in the horizontal. Maneuver in any plane is fulfilled by the creation of transverse g-force with respect to the course or the height/altitude.

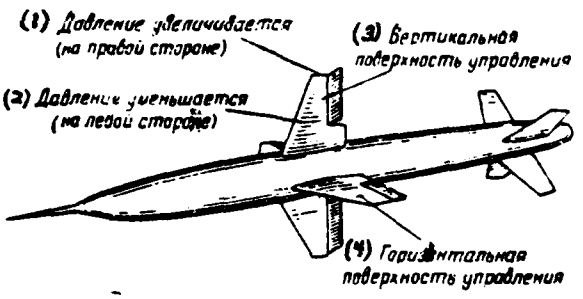

Fig. 6. The aerodynamic configuration of air-to-air missile.

Key (1). Pressure increases. (on the right side) (2). Pressure is decreased (on the left side). (3). Vertical control surface. (4). Horizontal control surface.

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Air-to-air missiles fly in lower and middle layers of the atmosphere; therefore for their guidance to the target are utilized only the aerodynamic forces, which appear on the controls and the wings as a result of moving the rocket in air flow. Besides aerodynamic, possible the jet guidance. It is applied on the flight vehicles, which accomplish flight into space.

Solid propellent rocket engines.

When we speak about the jet principle of motion, then we imply

the displacement of flight vehicle in the space by the effect of recoil force, i.e., the reaction of particle flux, rejected by rocket back/ago.

To establish/install division between the reactive/jet and nonreactive principles of motion is sufficiently difficult. From physics it is known that any movement by the water, in the air based on the reactive/jet principle, since occurs the rejection of the specific mass in the direction, opposite to the motion of apparatus. The screw/propeller of aircraft, throwing/rejecting back/ago the mass of air, creates the thrust which provides its flight. Steamship or warship is moved as a result of the reaction of the mass of the water, repulsed by back/ago screw propellers.

The motion of aircraft or steamship is accomplished/realized as a result of reacting the indirect action, since between the engine - the energy source - and by the rejected back/ago mass of air or water is an intermediate means - motor. For the aircraft motor is the propeller, while for the steamship - propeller. In the rockets the motor is absent; therefore the created by engine reaction is conventionally designated as the reaction of direct action.

Solid propellant engines find wide application in the air-to-air missiles, and also in the air-to-surface missiles they serve as the

basic or march sources of thrust for the guided and unguided missiles.

In structural/design sense the solid propellant engine has simple device/equipment. It consists of the cylindrical combustion chamber, output or jet nozzle, grain, explosive charge and diaphragm. The schematic diagram of solid propellant engine is given in Fig. 7.

Fuel/propellant in the solid propellant engines is located within the combustion chamber. Its odor is limited to the volume of chamber/camera.

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Depending on the type of fuel/propellant such engines can work short-term and comparatively for long: from the fractions of a second to several tens of seconds. Explosive charge is intended for the propellant ignition, and diaphragm prevents the ejection through the nozzle of the large/coarse pieces of the burning grain.

As the fuel/propellant for the solid propellant engines apply, besides powder, and other compositions, which are the solid connection of fuel and oxidizer.

Solid propellant engine, in spite of simplicity of construction/design, it is sufficiently complex in the production. This is explained, first of all, fact that the combustion chamber and jet nozzle work under conditions of large pressures (to 200-300 atm.), at a temperature of 2000-3000°C and exhaust gas velocity to 2500 m/s. The internal surfaces of the combustion chamber and nozzle sufficiently rapidly are destroyed and become unsuitable; therefore they are manufactured from the special high-temperature (strength) types of steel.

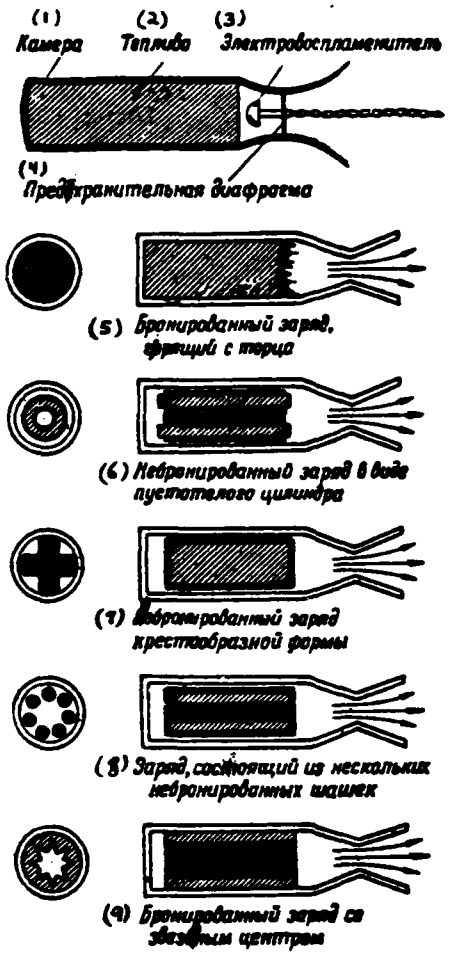

Fig. 7. Schematic of solid propellent rocket engine, which uses grains of various forms.

Key: (1). Chamber/camera. (2). Fuel/propellant. (3). Electric fuse. (4). Safety diaphragm. (5). Restricted-burning charge, which burns from end/face. (6). Unrestricted-burning charge in the form of hollow

cylinder. (7). Unrestricted-burning charge of cruciform form. (8). Charge, which consists of several uninhibited grains. (9). Restricted-burning charge with star center.

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The placed into the combustion chamber solid-propellant grain is the uniform mass, in each particle of which are contained the fuel and oxidizer. The burning of solid fuel occurs from the surface.

The quantity of gases, which appears at a constant pressure per unit time, is determined by the value of the burning grain surface. During the burning of grain the burning grain surface can grow/rise or be decreased. If burning surface is decreased, then is decreased a quantity of gases, which appear per unit time. This burning is accepted to call degressive. If burning surface increases, then grows/rises a quantity of gases, which are formed per unit time. This burning of charge is called progressive.

Giving to the solid-propellant grain one or the other configuration, it is possible to obtain the necessary law of the formation of fire gases, i.e., the necessary change-in-thrust pattern in the time.

In order to preserve the constancy of the engine thrust in the time, should be ensured the constant/invariable burning surface of grain. This is reached with the aid of the solid-propellant grains, prepared in the form of hollow cylinder. In the tubular grain the burnout of external cylindrical surface results in reduction, and the burnout of internal surface - to an increase in the burning area. Total burning surface virtually remains constant.

It is sometimes necessary to obtain the rapid combustion of fuel/propellant for obtaining the short powerful/thick impulse/momentum/pulse of thrust. In these cases the charge is made with multigrain.

For obtaining the charge with the long burning time (to tens of seconds) are applied the restricted grains. In them the part of the fuel/propellant is covered/coated with the plastic which does not burn and protects the covered surface of grain.

Jet nozzle is variable-area channel which is intended for an increase in the rate of the flow of the fuel combustion products.

Equipment for stabilization and control.

Sensing elements of the guided missiles are autopilot and

equipment for control.

Autopilot provides the consumption/production/generation of the signals, necessary for the stabilization of the position of rocket in the space, and consists of several gyroscopes and sensors.

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Gyroscope - these are the rapidly rotating gyroscope or the rotor, fastened/strengthened within one or two mobile framework, rigidly connected with the missile body.

Gyroscope possesses property to retain the prescribed/assigned position of its principal rotational axis independent of the inclination/slope of the housing of flight vehicle.

In order to simultaneously measure three angles (along the bank, on the course and on the height/altitude), necessary for the guidance of rocket to the target, in the autopilot they establish not less than two gyroscopes.

Prior to the missile takeoff the gyrorotors untwist. As a result of the fact that the framework of gyroscopes are connected with the housing of the flight vehicle through the sensors, with the random

shifts of rocket from the trajectory in the sensors appear the electrical signals, proportional to deviation. These signals then are strengthened and, acting through the control actuators on the controls of rocket, they return it to the trajectory of induction/guidance. So occurs the stabilization of rocket in flight.

But how does occur the guidance of rocket to the target, if target does maneuver or with the missile takeoff is allowed the error in the determination of the line of fire?

For the solution of these problems in the air-to-air missiles is provided for homing equipment or equipment of remote control.

Homing equipment utilizes the characteristic properties of target, which differ it from the surrounding background. With the aid of onboard homing equipment the rocket determines its location relative to the fired target and automatically it converges with it.

All aircraft possess the ability to emit the visible and infrared (invisible) rays/beams and sound vibrations. Furthermore, all aerial targets reflect electromagnetic energy which is emitted by radar transmitters.

At present in aviation rocket engineering sufficiently wide

acceptance received semi-active radar and passive thermal, or infrared, homing system.

Semi-active radar homing system is based on the use of electromagnetic energy, reflected from the target during its irradiation by aircraft radar sight.

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Semi-active self-homing head is placed in the nose section of rocket of class "air - air". It consists of antenna system, receiver and homing coordinator.

Antenna system is established under the radio-transparent cap/hood and is the parabolic reflector, in focus of which is placed receiving irradiator - special radio engineering element/cell which accepts the accepted by reflector signals of electromagnetic energy.

Reflector possasses property to accept the echo from the target pulses only in the specific region of space, on its form of that reminding the body of revolution, described by narrow and long lobe/lug. This region of space is called the antenna radiation pattern.

It is virtually established/installed, that the power of the accepted from the target signal of electromagnetic energy on the rotational axis of irradiator (or on the axis/axle of radiation pattern) for any constant distance is always more than in its edges. This important property of antenna system is utilized in the semi-active radar homer.

Examining/scanning the echo from the target signals on the special electronic device - oscillograph, it is possible to be convinced of the fact that during the determination of target by the rotational axis of receiving irradiator the value or the amplitude of the accepted from the target signals remains constant.

But if we the target of displacing relatively the so-called equisignal sector, shaped with the antenna system of self-homing head, then the value of the echo signals will periodically first increase, then be decreased. Charge in the value of the echo from the target signal in the time, or isolation/liberation of the error signal, occurs in homing coordinator after the preliminary amplification of useful signal in the receiver of self-homing head.

Homing coordinator - device/equipment, which makes it possible to continuously measure the angular coordinates of target relative to the axis of rocket of dogfight. It produces the voltages,

proportional tc the error signal in one or both control planes. These signals enter the channels cf the elevator control and of rudder of rocket and turn by their in such a way that would occur the apprcach of rocket for the target.

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Semi-active radar homers possess the high precision/accuracy cf induction/guidance. Ho wever, they are expensive and as any radar device/equipment, they can be subjected to the effect of radio interference.

But how do work thermal, or infrared, self-homing heads?

In the nature all bodies are the sources of infrared radiation 50o/o energy, emitted by the sun, it falls to infrared radiation.

It is established/installed, that the human eye accepts light vibrations in wavelength from 0.4 tc 0.76 μ. The invisible part of the spectrum composes electromagnetic vibrations on the wave from 0.76 to 750 μ. Infrared rays possess many properties of the visible rays/beams, but better they pass through black paper, ebonite, cardboard.

For the detection of aircraft on its thermal radiation/emission with the aid of the sensitive receivers it is necessary that the target would be arranged/located against the background whose thermal radiation is lower than the thermal target emission. Aircraft against the background of the atmosphere is the very effective radiating object.

The principle of the work of infrared homing head can be explained on the given in Fig. 8 diagram. Head includes optical system, receiver of thermal radiation and amplifier.

The emitted by target infrared rays are accepted by optical system, are refracted and are focused at one point of the thermal receiver, which is the photoelectronic indicator, which converts thermal energy into the electrical.

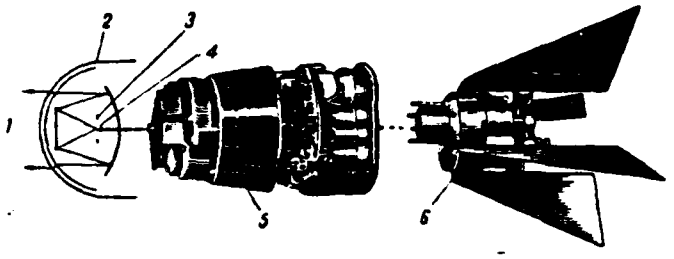

Fig. 8. Infrared homing head: 1 - infrared rays; 2 - fairing; 3 - modulator; 4 - receiver; 5 - amplifiers; 6 - drive of controls.

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If target will not be found on the continuation of the centerline of self-homing head, then photoelectronic indicator will reveal/detect a change in the position of the point of reception of heat rays relative to the focus of optical system, in consequence of which will arise the electrical signal, proportional to displacement angle between the target and the rocket.

This signal is strengthened in the electronic device and through the drives acts on the controls of rocket so as to return it to the trajectory of induction/guidance.

The characteristic feature of infrared homing heads is the high precision/accuracy of guiding rocket to target which increases in

proportion to approach for the target.

Important advantage of heat-seeking guidance systems - low cost/value of production. However, the work of infrared self-homing heads depends on the meteorological conditions (strong rain, fog/mist, snowfall), which substantially depress their range. The attack of the aerial target in the direction of the sun is also hindered/hampered.

In some air-to-air missiles is applied the electronic guidance equipment which holds rocket in the ray/beam, formed/shaped with the placed on the interceptor radar sight. Such systems are the variety of track-command guidances.

With the missile takeoff falls into the radio beam which preliminarily produced the "capture/grip" of target and it continuously accompanies it. For the retention of rocket in the radio beam are utilized the steering commands, isolated by the receiving equipment of rocket from the pulse train, emitted by the radar sight of interceptor.

After intensification the control signals through the drives act on the controls of rocket so as to hold rocket constantly in the radio beam which continuously tracks a target.

During the approach of rocket for the target occurs the blasting/detriment of warhead by proximity fuse.

Warheads.

In the air-to-air missiles wide distribution obtained fragmentation warheads; explosive charges are applied more rarely.

Fragmentation charge consists of explosive, included in the metal shell.

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With its blasting/detriment is formed a large quantity of metallic fragments, which fly at a high speed (in the limited zone). Upon the encounter with target they destroy the vital elements/cells of target aircraft.

The value of fragments, the direction of dispersion/divergence and the rate of their flight are determined by the structural/design characteristics of warhead.

The size/dimension of fragments is determined by the places of cuts on the metal shell of warhead, thanks to which the shell is destroyed in the places with the thinner cross section.

The rate of the dispersion/divergence of fragments is determined by the relationship/ratio between the weight of shell, weight and form of explosive. The cone of burst depends on the place of the blasting/detriment of warhead with respect to the target.

In the conventional warheads as explosives frequently is utilized trinitrotoluene or trotyl. Pure/clean trotyl - crystalline substance of the pale yellow color, safe in the inversion.

Under specific conditions trotyl can detonate/knock. The essence of detonation consists in the fact that this explosive is not ignited, as powder, from one layer to the next, but instantly it is converted into the gaseous state.

For the detonation of trotyl are utilized two detonators, from which primary is capsule with the mercury fulminate, and secondary - powder-like pressed trotyl.

Explosive warheads differ from fragmentation ones only in terms of the fact that in them is utilized the thinner metal shell. The

weight of explosive in the fragmentation warhead composes 8-10o/o, and in the explosive it reaches to 15o/o of total weight of charge.

The blasting/detriment of primary detonator is produced with the aid of the proximity fuse.

Besides conventional warheads, in the air-to-air missiles can be used the atomic charges. However, similar warheads did not receive wide acceptance. Actually only the one American unguided rocket "Genie" is adapted under the atomic charge.

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Proximity fuses.

Practice showed that even the most modern rocket guidance systems cannot at a great distance ensure the direct hit into the high-speed/high-velocity manuvering aerial target.

Contemporary technology makes it possible to manufacture such proximity fuses which provide the blasting/detriment of warhead at the most advantageous moment/torque in order to cause maximum loss to target.

Proximity fuses are based on the use of different physical properties of target. Wide distribution received the radio-detonators which can be pulse and with the continuous radiation/emission.

Pulse fuse has low-power portable transmitter, receiver and sufficiently complicated antenna system usually of the slot type which consists of the transmitting and receiving antennas.

Upon the start of transmitter are produced the impulses/momenta/pulses of electromagnetic energy which through the transmitting antennas are emitted into the specific region of space.

During the incidence/impingement of the impulses/momenta/pulses of electromagnetic energy on the target from it begin to be reflected the radar echos. They are accepted by receiving antennas, are strengthened in the radio receiver, then they are supplied into that totalling, or storage, device/equipment. This device/equipment with the specific value of the resulting electrical signal ignites the detonator which undermines warhead.

In the controlled air-to-air missiles find use the proximity fuses, based on the Doppler effect - velocity-field, i.e., the fuses, which consider a difference in the frequencies of the emitted and echo from the target signals.

The physical essence of the Doppler effect - velocity-field can be understood based on the example of the moving/driving tone source, moved relative to fixed observer. It is easy to note that when the steam locomotive rapidly passes by station, the tone of whistle with the approximation/approach to an observer always higher than during the removal/distance from it. This occurs because to the velocity of sound vibrations during the approach of the velocity of steam locomotive is added, and during the removal/distance - it is deducted.

A similar phenomenon is also observed with the reflection from the target of the electromagnetic vibrations, emitted by radio-detonator.

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In the fuse occurs the isolation/liberation of the difference between two radio-frequencies (emitted and taken from the target), due to what is isolated the so-called beat frequency. It is established/installed, that its value is proportional to the radial velocity of the motion of the target of the relatively aimed at it rocket. Upon reaching/achievement of the specific beat frequency

occurs the operation of radio-detonator. The blasting of charge usually is fulfilled at the minimum distance between the target and the rocket.

The radio-detonator of continuous radiation/emission has the same elements/cells, as pulse radio-detonator.

For plotting the greatest damage to target they attain the specific agreement between the zone of burst and the radiation pattern of the antenna system of fuse on characteristics of which depends the region of the irradiated space.

Launchers.

Launchers are the independent part of aircraft equipment, which is intended for guaranteeing rocket launching. For this on the fighters are applied fixed guides of different constructions/designs. For example, for the unguided rockets "Mighty Mouse" utilize the streamlined containers which are fastened at the tips of the wings of fighter.

Fig. 9 shows the appearance of container to 24 rockets. It consists of the metallic streamlined framework/body. Within the container are attached by 24 the tubular guides. In each of them is

established one rocket. Rocket launching is produced with the aid of the electric fuse which ignites solid fuel in the jet engine.

Fig. 10 shows the appearance of more complicated fuselage launcher for the unguided rockets, which before the firing with the aid of the drives is advanced outside.

The suspension of the controlled air-to-air missiles usually is produced on the external launchers. In the foreign prass it was noted, intended for the relatively large/coarse rockets, it is conjugated/combined with an essential deterioration in the aerodynamic properties of carrier aircraft.

Launching configuration for the controlled air-to-air missiles has simple device/equipment and consists of the metallic non-guiding fastening locks and starting/launching automation.

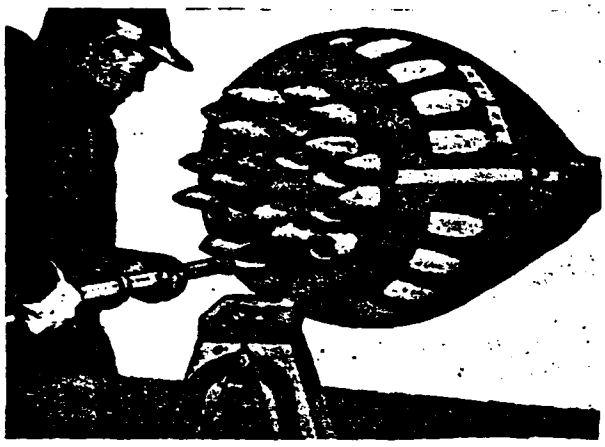

Fig. 9. The appearance of container to 24 unguided rockets, fixed to the arm wing.

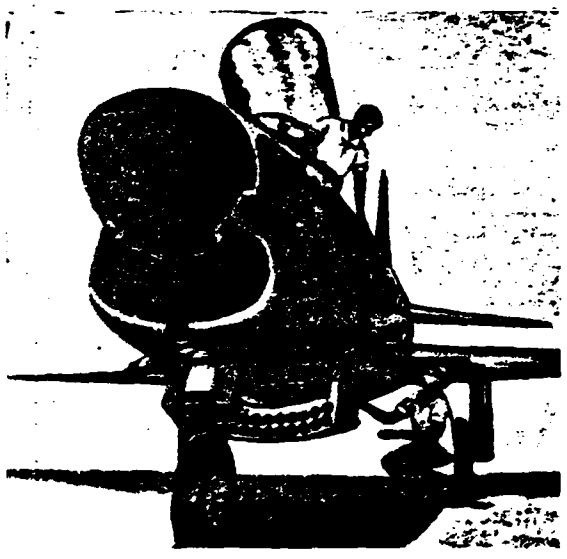

Fig. 10. Type of retractable launcher.

Fig. 11 shows the suspension of English projectiles "Firestreak missile". Under the left and right wing are symmetrically placed being guided and the locks, to which are fastened the rockets. The shock absorption of rockets during their transportation is provided with the aid of the springs. For decreasing the drag, created by the launchers of fighter, external mechanisms by fairings.

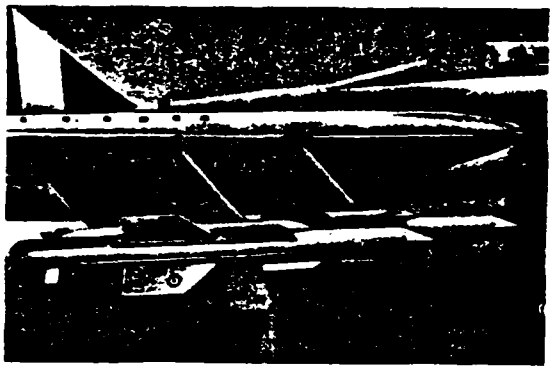

Fig. 11. Launchers for the guided missiles "Firestreak missile".

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Chapter II.

Aircraft rocket weapon of class "air - ~~the Earth~~ to surface".

In the postwar years in the arsenal of the means of the air defense of the series/row of the countries appeared the very effective weapon, capable of striking the aerial targets over a wide range of heights/altitudes. It includes the AA guided missiles, and also all-weather fighter-interceptors, which sufficiently successfully can carry on combat with the subsonic and transonic bombers at the average/mean and high altitudes.

In connection with the intensification of air defense the supporters of the manned aviation give much attention to further improvement of aircraft armament. Many foreign specialists consider that under contemporary conditions the losses of bombardment aviation can be substantially lowered due to the use/application of the unguided and controlled air-to-surface missiles.

Fundamental characteristics of the unguided and controlled air-to-surface missiles.

For the firing at the tanks, the lasting weapon emplacements and other well shielded ground-based units in the American combat aviation are employed the unguided rockets "Zuni" which are intended for the armament of fighters and fighter-bombers.

"Zuni" weigh approximately/exemplarily 50 kg and are aluminum cylinder in long approximately 3 m and diameter of 12 cm. In the pointed nose section of the rocket is placed fragmentation warhead. For "Zuni" are created several types of warheads and fuses.

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The large part of the housing occupies solid propellant engine. At the end of the rocket are folding fins which are opened after start from the action of exhaust jet.

Of not guided by rocket "Zuni" it is possible to strike ground-based (above-water) objects at the distance to 9 km. Toward the end of the work of engine the rocket develops the considerable

rate which exceeds sonic three times (ZM). Launchers are hung under the wing of aircraft. Each of them is intended for the transportation of four rockets. After firing the launchers are thrown off.

For the fire support of ground forces of the USA consists as arms the guided missile "Bullpup" with the range to 5-9 km. It weighs about 260 kg and develops the maximum speed of 620 m/s. The remote controlled part with the warhead weighs about 110 kg, the length of rocket is more than 3 m, the diameter of housing 30 cm, the wingspan of approximately 1 m. On the rocket is established/installed the solid propellant engine.

"Bullpup" is guided to the target with the aid of the radio commands. Using the knob control of radio-electronic guidance equipment, pilot transfers commands/crews "upward - down" and "to the left - to the right" relative to the line of sighting to the target. Observation of the fired object is conducted with the aid of the optical instrument.

The examined rockets "Zuni" and the "Bullpup" have short range; therefore under conditions of the counteraction to strong PVO [ПВО - Air Defense] of the loss of the attacking aircraft - the carriers of these rockets there will be the same as the losses of the fighter-bombers, armed by usual bombs.

As arms of strategic aviation of the USA is located two types of the controlled air-to-surface missiles - "Rascal" and by the "Hound Dogs", which have the considerable range, which, in the opinion of the foreign specialists, makes it possible to strike the objects, well shielded by the antiaircraft missile systems.

Thus, bombers of the type B-47, armed by rockets "Rascal" can strike with atomic charges ground-based objects at the distance to 160 km, without entering into the air defense zone of the covered object.

"Rascal" - sufficiently bulky and heavy cruise missile.

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Its launching weight of approximately 6 t, overall length of approximately 10 m, diameter of housing 1,2 m, wingspan of more than 4 m (Fig. 12).

On the rocket is established/installed the three-chamber liquid propellant rocket engine, which develops gross thrust in 5400 kg.

"Rascal" has aircraft layout; however, it is made on the aerodynamic configuration of "weft", i.e., its trapezoidal controls are placed in the forward section, and small wings are fastened to the aft body.

For the transportation the rocket is hung under the wing of aircraft on the right side of fuselage. Powerful/thick march liquid propellant rocket engine accelerates/disperses rocket to the rate, one and a half times which exceeds the speed of sound (1.5 M).

Its guidance to the target is produced with the aid of the autonomous inertial guidance system or radio commands, transferred from the carrier aircraft.

Rocket "Hound Dog" is intended for the damage/defeat by the nuclear charge of ground-based (above-water) objects at the distance to 800 kg (Fig. 13). As the carrier aircraft is utilized the strategic bomber B-52, which has flying range to 16000 km.

"Hound Dog" is made on the aircraft configuration, weigh 4.5 t and have sufficiently large sizes/dimensions. Its length about 13 m, span of wing approximately/exemplarily 3 m, maximum/overall diameter of housing 70 cm. Turbojet engine develops the thrust in 3.6 t, which communicates to rocket cruising flight speed of approximately 500 m/s.

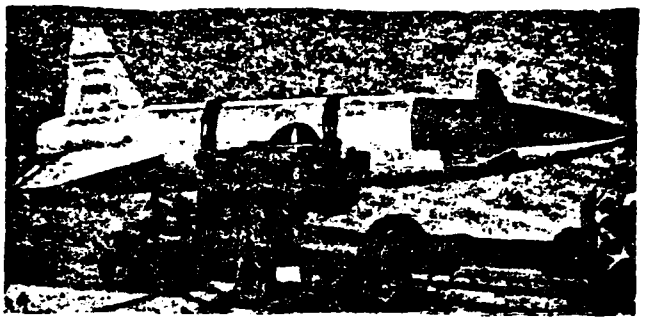

Fig. 12. Guided missile "Rascal" established/installed on the transport-loading bogie/carriage.

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For the conclusion/derivation to the target is utilized inertial guidance system. The precomputation of course and flight altitude of "Hound Dogs" is produced with the aid of the aircraft calculating equipment. After accomplishing of calculation are necessary the data they are introduced into the onboard equipment, which is located on the rocket. The same rocket can be used for the creation of radio interference to the radar systems of control of surface-to-air missiles and to the stations of detection. For this in the rocket instead of the nuclear charge is provided for the arrangement/position of equipment of radio interference.

In England is developed rocket "Blue Steel." Outwardly it is similar in American of rocket "Rascal," but it is heavier than the

latter approximately/exemplarily to one ton. "Blue Steel" is also equipped with nuclear charge. The established/installed on it liquid propellant rocket engine provides rocket flight with a velocity of 450 m/s at the distance to 540 km. On the basis of other sources, the range of rocket has high value. On "Blue Steel" is also used inertia guidance equipment. As the carrier aircraft are utilized the bombers "volcano". Rocket is hung outside under the fuselage of carrier aircraft.

Fig. 13. Transportation of the long-range controlled air-to-surface missiles on the strategic bomber.

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Fundamental characteristics of aircraft ballistic air-to-surface missiles.

Besides winged air-to-surface missiles, on the strategic bombers can be transported the ballistic missiles, which after start from the carrier aircraft are built up to the height/altitude into several hundred kilometers and after cessation the work of jet engine their further flight fulfill along the ballistic trajectory.

In the USA were recently carried out the tests on the starting/launching of ballistic missiles from the manned bombers. These starting/launching showed the possibility in principle of applying the carrier aircraft as the mobile launchers. The series/row

of foreign specialists considers that the aviation ballistic air-to-surface missiles are perspective air weapon system, since they remove the periods of the displacement of the strategic bombers by intercontinental rockets.

The aircraft, armed by ballistic missile, is the peculiar flying launcher which possesses this important advantage as mobility and the possibility of rapid retargetting.

At present for the armament of the strategic bombers B-52 is developed/processed ballistic air-to-surface missile "Skybolt." It is intended for the damage/defeat of the important objects of the enemy by nuclear charges at the distance 1600-2400 km from the place of starting/launching from the aircraft (Fig. 14).

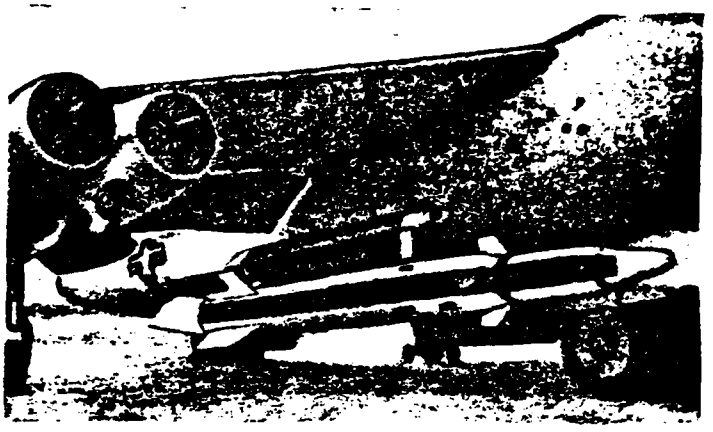

Fig. 14. Appearance of aircraft ballistic missile "Skybolt."

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In the foreign press it was communicated that the rocket "Skybolt" will be started from the aircraft, which flies at height/altitude 10500-13700 m with a velocity of 960 km/h, and reach in flight along the ballistic trajectory of the height/altitude of 320-480 km. The flight speed of rocket is more than 2 km/s.

This rocket is made in the form of two-stage flight vehicle. The overall length of "Skybolt" of 7.5 m; the length of first stage 5.4 m, the second - 2.1 m. At first stage are established/installed long fixed stabilizers. The second, or march, step/stage is equipped with the aerodynamic controllers which are placed in the forward section of the rocket - the diagram of "weft", and are intended for the

output of rocket to the trajectory of induction/guidance in the atmosphere. Control in the vacuum is intended to fulfill with the aid of auxiliary jet engines, placed in the nose section of the second stage of rocket.

On the bomber B-52 is provided for the simultaneous transportation of two ballistic missiles. For guaranteeing balancing/trimming aircraft they will be thrown off from the launchers simultaneously. The solid propellant engine of first stage is intended to include at the smallest possible from the carrier distance. Duration of the work of engine, or the duration of the powered flight of rocket, about 60 s.

After engine starting on the command/crew, subject from the carrier aircraft, the rocket will pass from the level flight to the climb with the subsequent ballistic trajectory flight.

In target area the rocket will enter in the atmosphere at the relatively flat angle (on the order of 40°), which must decrease heating its second step/stage. For the protection of warhead from the superheating is applied the cone from the high-temperature (strength) plastic materials.

Foreign specialists confirm that the development of ballistic

aircraft missiles did not cause great structural/design difficulties. Exception is the manufacture of guidance equipment. Equipment must ensure continuous presentation of information about moving coordinates of bomber, are which prior to the start necessary to introduce into the calculating equipment rockets. Will be there previously introduced the target coordinates.

From the precision/accuracy of the work of guidance equipment as the final result will depend the amount of deflection of warhead relative to the object of damage/defeat.

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Aerodynamic configurations of air-to-surface missiles. Schematics of ballistic aircraft missiles.

The aerodynamic configurations of the unguided air-to-surface missiles in principle in no way differ from the unguided air-to-air missiles to which we briefly were introduced in the preceding/previous chapter.

After examining the concrete/specific/actual samples/specimens of the controlled air-to-surface missiles, it is possible to draw the conclusion that in these constructions/designs is given up the

preference to the aircraft configuration of layout (besides ballistic missile "Skybolt").

This is caused, first of all, by the complexity of the external suspension of sufficiently large and heavy rockets to to carriar-aircraft.

The guided missiles with the crossed wings would prove to be bulkier flight vehicles in comparison with the analogous rockets, made on the aircraft configuration.

In the air-to-surface missiles, that have the aircraft configuration of layout, control is usually accomplished/realized by the tail or front control surfaces.

By their construction/design the guided missiles "Rascal," "Hound Dog" and "Blue Steel" are similar to the small aircraft.

The longitudinal load-bearing elements of the streamlined missile body are long longerons/spars; transverse loads accept frames and frames/formers, established/installed at specific distance one from another.

In rocket and aviation equipment by the longeron/spar is

accepted to imply the element/cell, arranged/located along the missile body or wing and that receiving in full or in part the bending moments.

Frames and frames/formers are intended for imparting the prescribed/assigned form to the missile body and fastening of skin/sheathing. Furthermore, frames/formers strengthen the construction/design of rocket.

Missile body they usually face/trim with thin aluminum sheets. Skin/sheathing in the construction/design of housing accepts the part of the bending moment. In the wings sometimes instead of the longerons/spars are utilized honeycomb type constructions/designs.

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In this case all efforts/forces, applied to the wing, bear the skin/sheathing and its filling honeycomb elements/cells. In the external riveting skin joints the housings and the wings apply countersunk rivets. The characteristic feature of wings and tail assembly is their large sweepback. Swept constructions/designs have relatively small resistance at supersonic speeds the rates and in this respect they more preferable than rectangular ones.

Aircraft ballistic missile does not have wings and is cigar-shaped metal housing with the small controls. These flight vehicles depending on designation/purpose can be single-stage or two-stage.

Structurally/constructionally rocket consists of several sections, intended for positioning/arranging the warhead, equipment for control and stabilization, drives and engine installations.

For the stabilization in the initial trajectory phase serve fixed stabilizers, fixed to the aft body in two mutually perpendicular planes. Controls in the initial trajectory phase are usual air vanes.

At the high altitudes in the aircraft ballistic missiles is applied the jet guidance. One of the methods of jet guidance consists in the use/application of the jet vanes, which are the graphite plates, placed in the gas backwash. The work of these controls does not depend on the flight speed of rocket and presence of the atmosphere.

Is in principle possible the use/application of jet pivoting motors to the missile body. Changing the position of engine relative to axis of rocket, it is possible to obtain the necessary lateral

forces.

The simpler diagram of jet guidance is based on the use of pilot engines, intended for the creation of the augmented thrust, applied in two control planes. For this in the housings of rocket are cut through exhaust nozzles, through which escapes the gas flow of pilot engine, which creates necessary side components of steering commands.

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Engine installations of air-to-surface missiles.

On the rockets "Rascal" and "Blue Steel" are established/installed the liquid propellant rocket engines (ZhRD [(ЖРД) - liquid propellant rocket engine]) which on their device/equipment are more complicated than solid propellant engines. Liquid propellant rocket engines work on the liquid propellant which usually consists of two components - oxidizer and fuel.

Fuel includes the elements/cells, capable in the process of chemical compound with the oxidizer to isolate the necessary quantity of heat. Oxidizer is oxygen or another oxygen-containing substance.

ZhRD is the composite/compound component part of the engine

installation into which, besides engine, enter the propellant feed system and control system.

Liquid propellant rocket engine consists of head, injectors, combustion chamber, exhaust nozzle and the so-called cooling jacket (Fig. 15).

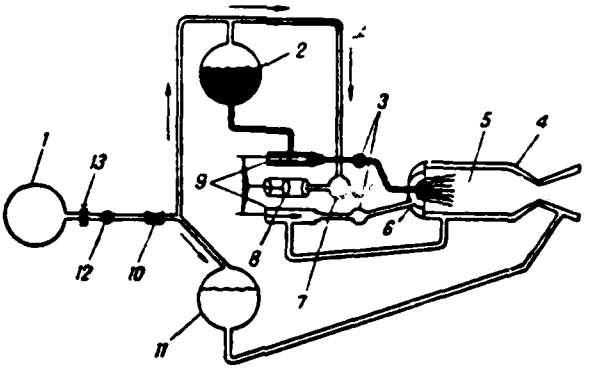

Fig. 15. The schematic of liquid propellant rocket engine with the pressureized feed of the fuel/propellant: 1 - compressed air tank under the pressure; 2 - fuel tank; 3 - regulating nozzles; 4 - cooling jacket; 5 - combustion chamber; 6 - injector; 7 - hydraulic accumulator; 8 - actuating cylinder; 9 - fuel valves; 10 - starter valve of engine; 11 - oxidizer tank; 12 - air reducer; 13 - valve/gate of tank/balloon.

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In the engine head are established the injectors through which inject into the combustion chamber those finely pulverized the fuel and oxidizer. Fuel/propellant in the combustion chamber with the work of jet engine must be distributed evenly.

Burning with the greatest heat liberation will occur in such a case, when fuel and oxidizer will be supplied into the combustion

chamber in the necessary proportion with the mandatory formation of the most uniform possible mixture from the propellant components.

In contemporary ZhRD are applied jet-edge and swirl injectors. The jet injector creates the narrow long flame of fuel/propellant. The best atomization of fuel/propellant is reached with the aid of the swirl injectors in channels of which the fuel/propellant obtains rotary motion. Under the action of centrifugal forces the smallest drops of fuel/propellant are distributed more evenly. In the engine head are sometimes established simultaneously jet-edge and swirl injectors.

The propellant component flow through outlets is determined by a drop/jump in the pressure and by the transverse flow passage cross-sectional area of injectors.

Combustion chambers of ZhRD can be two geometric forms: cylindrical and spherical (or close to it). Spherical chamber/camera with the identical to the chamber/camera of cylindrical form volume has smaller surface and smaller weight; however, is more complicated in the manufacture. Cylindrical chamber/camera in this respect is more convenient.

Combustion chamber of ZhRD converts/transfers into the nozzle,

which is the channel whose cross section first is decreased, and then increases in the specific law. Nozzle is intended for an increase in the rate of the flow of the cooling-cut gases.

It is experimentally established/installed, that the supersonic exhaust gas velocities can be obtained in the so-called Laval nozzle. The flow of gases, entering the nozzle with supersonic speed, in its tapering portion slows down, and in that expanding - it is accelerated.

Geometric nozzle configuration is selected by such that losses in the rate would be as less as possible, and the surface of nozzle was smallest. Intake and nozzle exits for decreasing the losses to the friction are made as far as possible by short ones.

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In the combustion chambers ZhRD with the combustion of two propellant components is develcped absolute temperature to 3000°. Therefore for the preservation of engines from the decomposition must be cooled them.

Is very extended the external cooling of liquid-propellant engine by one of the components of the propellant, driven away

through the cooling jacket, formed by the double combustion chamber walls. This method of cooling is convenient fact that there is nc need for in the supplementary cooling liquids and engine installation has minimum weight; however, the use/application of an external method of ccoling is connected with the definite difficulties.

Sometimes in ZhRD is applied the internal cooling, based on the supply of surplus quantity of fuel to the combustion chamber walls, thanks to which is created peculiar shielding curtain. The action of curtain consists in the fact that the liquid as a result of heating and evaporation deducts heat in wall, and it also depresses the temperature of that layer of gas which directly comes into contact with the surface of combustion chamber.

Is possible the use/application of composite cooling during which the internal cooling decreases the heat flux, transferred to walls, and external - abstracts/removes it from the walls.

The feed system and regulation includes the complex of different elements/cells of the engine installation: aggregates/units for supplying the fuel/propellant, conduits/manifolds, reducers, air intakes, branch and other elements/cells, necessary for the reliable self-operation of ZhRD.

On the American rocket "Bcund Dog" is established/installed the turbojet engine (TRD [(ТРД) - turbojet engine]). Turbojet engines are the variety of jet engines. As the fuel they utilize a liquid propellant component, while as the oxidizer - oxygen of the environment.

Turbojet engine consists of diffuser, compressor, combustion chamber, gas turbine and nozzle, contained in the metal housing.

In the diffuser occurs the transformation of velocity head of the incident flow into the static pressure. From the diffuser the air falls into the compressor, in which occurs the air compression. In TRD are applied the compressors of two types - axial and centrifugal.

Axial-flow compressor consists of the set of fastened with each other rotor wheels.

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Fig. 16 shows diagram of TRD with the axial-flow compressor.

As can be seen from the given diagram, between rotor wheels of axial-flow compressor are placed the blades of fixed guiding device, intended for braking of air flow.

Each wheel of axial-flow compressor with the subsequent series/row of vanes is the independent step/stage, which ensures an increase in the pressure cn 20-30o/c. In the engine they establish from 6 to 16 such steps/stages.

Air compression can be made by the centrifugal compressor in which the entered through the central opening/aperture air is caught by impeller blades and is thrcwn/rejected from the center of circle. With an increase in the speed of rotation of impeller is raised the air pressure. Cantrifugal compressors usually are single-stage.

Combustion chamber is placed between the turbine and the compressor, they are which they are connect/joined together by shaft. For the protection of shaft frcm the effect of high temperatures one overall chamber/camera they replace by several separate chambers/cameras, placed arcund the shaft in the circle/circumference. In each chamber/camera for the propellant atomization is an injector. Furthermore, in one - two chambers/cameras are electric lights for the propellant ignition during engine starting. In the remaining chambers/cameras the inflammation of fuel is produced from the flames of these chambers/cameras with the aid of the connecting tubes. For engine

starting in the combustion chambers are established supplementary injectors.

The temperature of fuel in the combustion chamber of flame reaches 2000°C. The entering from the compressor air is divided into two flows.

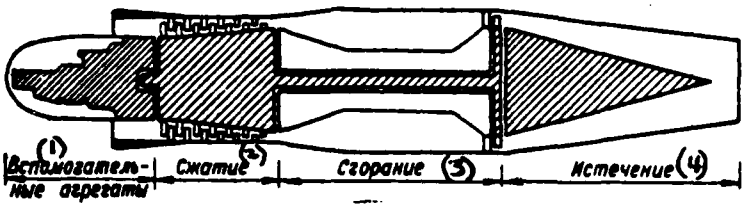

Fig. 16. Schematic of axial-flcw jet engine.

Key: (1). Auxiliary units. (2). Compression. (3). Combustion. (4) Outflow.

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Approximately/exemplarily the fifth part of the air is supplied into the flame tube, i.e., intc that part of the chamber/camera where occurs the basic process cf burning. Remaining air, washing frcm the outer side flame tube, cools it. The coming-out from the flame tube gases are mixed with the entire mass of air and is formed gas-air mixture with temperature of 850-900°C.

The placed after gas turbine combustors is intended for rotating the compressor. Rotary effort/force from the turbine is transferred through the coupling shaft. Structurally/constructionally gas turbine is very similar to the compressor. This can be explained by the similarity of the occurring in them physical processes.

Turbines can be respectively radial and axial. In contemporary TRD [turbojet engine], as a rule, are applied axial-flow compressors and axial-flows turbine.

For an increase in the rate of exhaust gases behind the turbine is established/installed the jet nozzle, made in the form of the

conical convergent nozzle, before which is placed transition element/cell - exhaust cone.

In flight of rocket contrary air flow through the inlet enters the compressor, in which occurs the air compression.

The compressed air is supplied into the combustion chambers, where is injected liquid fuel. There occurs the formation of combustible mixture and its burning.

From the combustion chamber the gases fall to the fixed nozzle blades; here pressure falls, but increases the rate of flow to several ones from the meters per second.

From the nozzle blades the gases are directed to the impeller of the gas turbine whose blades are profiled in such a way that with the flow of gases appears torque. This forces to rotate turbine wheel with the enormous rate. Combustion products the large part of their kinetic energy transfer to rotor wheel; therefore behind the turbine they have a comparatively low speed and a pressure, which exceeds atmospheric 2-2.5 times. The final expansion of gases occurs in the jet nozzle.

Thus, in contrast to ZhRD [liquid propellant rocket engine] and

solid propellant engine turbojet engine has moving elements.

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As it was noted earlier, on the aircraft ballistic missile "Skybolt" is provided for the use/application of a solid propellent rocket engine. Its device/equipment in principle in no way differs from the device/equipment of the engines, used in the air-to-air missiles. It is obvious that the power of engine is selected taking into account the weight of ballistic missile, required rate and flying range.

In the engines of the forward reaction examined which find wide application on all types of aviation rocket weapon, thermal energy is converted substances kinetic due to the expansion of combustion gases and their motion through the nozzle.

The directed outflow of gases leads to the emergence of thrust force. In the wide concept the thrust force is the axial of the resultant force of pressure, distributed over the entire surface of flight vehicle.

The thrust components are the pressure of gases, ejected back/ago from the engine and effecting on its internal surface, and

the axial force of atmospheric pressure, applied to the external surface of rocket. The created with jet engine thrust accomplishes the work which is spent on overcoming of resistance in flight of rocket.

Guidance equipment for air-to-surface missiles.

In the air-to-surface missiles is applied the so-called inertia guidance equipment. This equipment relates to the variety of the autonomous control systems, i.e., such systems which do not depend on the external sources of information.

Into inertial guidance system enter:

- accelerometers, or accelerometers;

- computers, or integrators;

- gyrostabilized platform.

Accelerometers are sufficiently to simplicity the sensitive device/equipment, in which there are spring-mounted load, or inert body, potentiometer and damper (Fig. 17).

With a change in the rate of rocket in acccrdance with the laws cf physics the inert body attempts to preserve its initial position, in consequence of which occurs the displacement of body relative to the missile body and connected with it housing of accelerometer.

The amount of the displacement of inert body is fixed/racorded with the electrical potentiometer with runner of which is rigidly connected the load. Elastic force of spring is selected in such a way that it balances the inertial force, applied to the load. If the acceleration of load is equal tc the acceleration cf rocket, than load will not move relative tc missile body and the wiper will remain at point with the zero voltage.

With weight shifting under the action of the inertial forces, caused by emergence in the rocket of side accelerations, the inert body acts on spring with the force, proportional to acceleration.

Under the effect of the inertial forces the load will remain on the spot, and the connected with the housing wiper will move for the value, proportional tc the side acceleration cf rocket, tc what will correspond the value of the positive or negative stress/voltage, removed from the output/yield cf accelerometer.

At present in the inertial systems are applied the new types of the accelerometers, which pcssess high precision/accuracy and simple in the device/equipment. In these meters is used the principle of the vibrating plate the fraquency cf which depends on the value of the applied acceleration. Fcr rate measurement it is necessary to sum up the total quantity of oscillatcry periods for the time unit.

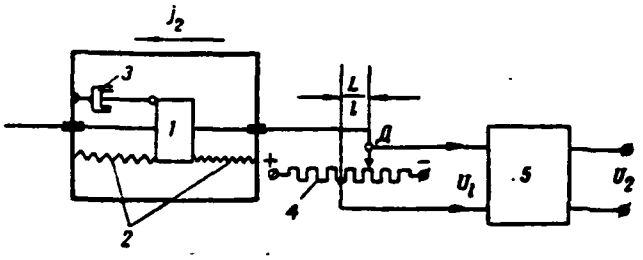

Fig. 17. The schematic diagram of the accelerometer: 1 - inert body (load); 2 - spring; 3 - damper; 4 - potenticmeter; 5 - unit of integrators.

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From physics it is known that upon the uniform acceleration the rate of any mass is proportional to the product of acceleration to the period of its action.

With the guidance of rocket to the target its acceleration continuously changes value and sign. For determining the average speed the rockets in entire section of induction/guidance with an arbitrary and continuous change in the acceleration entire time interval of the action of acceleration divide/mark off into the series/row of the very small temporary/time subintervals, for each of which is measured the average acceleration. The product of average acceleration to the value of the corresponding subinterval will give

a velocity increment in each measured section.

For calculating true airspeed of rocket it is necessary to consecutively/serially multiply average accelerations to the duration of each subinterval, and then taking into account the sign of the velocity components to produce the consecutive summation of all components.

This process is called integration, and the instrument, with the aid of which automatically are produced the multiplication of accelerations to the time intervals and the summation of components of velocity of rocket, it is called integrator.

Damper is intended for the decrease under the spring effect of the harmonic oscillations of inert body relative to the point, which corresponds to the true acceleration of rocket.

For measuring all displacements/movements of rocket it is necessary to produce the multiplication of corresponding components of velocity of rocket to the period of their action. These operations/processes make the unit of integrators from output/yield of which are removed/taken the stresses/voltages, proportional to the displacements/movements of rocket.

Unit is placed on the special platform, stabilized in flight with the aid of two or three gyroscopes in such a way that its position does not depend on the position of rocket in the space. The stabilization of platform is provided with the aid of the electrical or pneumatic drives, to input of which enter the control voltages from the potentiometers of gyroscopes.

Accelerometers place on the gyrostabilized platform so that their measuring axes/axles would be perpendicular to each other. Each of the accelerometers determines one of the components of the acceleration of rocket in the coordinates of inertia space.

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The accelerometer of pitch determines the accelerations, which appear in the rocket with its displacement/movement in the vertical control plane. The accelerometer of longitudinal accelerations measures the accelerations in the missile heading, while the accelerometer of course - with its deviation from range plane.

After dual integration in the inertia guidance equipment are produced the stresses/voltages, which correspond to the amount of deflection of rocket from the trajectory of induction/guidance or to the value of the covered path. After intensification these

stresses/voltages through the autopilot act on controls, in order to return rocket to the trajectory of induction/guidance or to transfer it into the dive upon the reaching/achievement by the rocket of the calculation point of damage/defeat.

For the effective combat employment of the controlled air-to-surface missiles at the moment of their starting/launching it is necessary to accurately know the coordinates of carrier aircraft. In the foreign press it was communicated that these data automatically are introduced into the guidance equipment of rocket into the established/installed on the aircraft astro-inertia system, which possesses the broad band of the measured accelerations and velocities, and also the relatively high precision/accuracy of work.

Warheads of air-to-surface missiles

The target of the combat employment of the started from the aircraft rockets is the delivery/procurement of warheads to the selected objects.

In the second World War for the destruction of diverse ground-based, above-water and aerial targets were utilized the conventional warheads. At the end of the war appeared the first samples/specimens of nuclear weapons. Americans with the aid of the

heavy aircraft supplied to the Japanese cities, which do not have military value, the first A-bombs. In the postwar years nuclear weapons continued continuously to be improved and to be developed.

Nuclear charges are subdivided into the atomic ones and the hydrogen ones (thermonuclear).

In the atomic warhead of rocket the energy is isolated due to fission reaction of the atomic nuclei of heavy chemical elements. Isolatable during the atomic explosion of the warhead of rocket energy is formed in the presence of the fission chain reaction of uranium-233, uranium-235 or plutonium.

During the atomic explosion is isolated enormous energy content, which causes large decomposition to object.

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As is known, all bodies consist of the smallest particles - the molecules which possess all properties of one or the other substance. Molecules in turn, include different quantity of connected with each other atoms.

The atom on its structure resembles the structure of the solar

system. In the center is located the nucleus, around it rotates certain quantity of negatively charged/loaded particles - electrons. Atom does not have free electrical charges; therefore its nucleus is charged/loaded by the positive electric charge, equal in terms of the absolute value to the total net charge of negative electron shell.

Soviet scientists D. D. Ivanenko and Ye. N. Gapon demonstrated that the atomic nuclei consist of two forms of particles - positive protons and neutral neutrons.

From physics it is known that between the electric charges there are forces of interaction. If charges have opposite signs, they are attracted/tightened to each other, while if identical - are repulsed.

The located in the nucleus heavy protons are repulsed from each other with the enormous force. Besides repulsive forces, in the nucleus are attracting forces, which effect between the groups of the so-called nucleons (protons and neutrons). The attracting forces and repulsion of each other neutralize.

Under the effect of the intranuclear forces under specific conditions occurs the spontaneous division of the heavy atomic nuclei of uranium or plutonium, i.e., their decomposition/decay into the unequal parts. Initially upon decay of one nucleus are isolated

several neutrons which fall intc the adjacent nuclei and destrcy them. As tha final result this leads to the emergence of avalanche-type chain reactiсn.

In the atomic charge tke chain reaction will occur in such a case, when warhead contains tke specific quantity of radioactive material. The smallest volume of radioactive material, with which is feasible the atomic explosicn, is called critical. In the foreign press it was nоted that the weight of the critical charge, prepared in the form of sphera, composes several kilograms. The large pieces of radioactive uranium-233, cranium-235 and plutonium not at all can exist.

Let us examine one of the pcssible schematics of the device/equipment of the atomic warhead of air-to-surface missile (Fig. 18).

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It consists of shell, two disccnnected pieces of radioactive uranium or plutonium, two reflectcrs, charge of conventional explosive, detonatcr and fuse.

Within the metal shell of head is a cylindrical cavity at ends

of which are placed two pieces of uranium-235 (or another fissionable material). The mass of each of them is lower than the critical, and their total super-critical mass.

For the compound of two pieces of fissionable atomic material and obtaining of its critical mass are utilized the usual charges, which during the explosion cause the almost instantaneous contact of two pieces of fissionable material (Fig. 19).

The explosive force will be the greater, the more rapid and the more uranium atoms will enter the reaction. Thus, explosive force is proportional to the coefficient of the use of the fissionable material.

In the atomic warhead are applied neutron reflector from graphite or oxides of beryllium. Reflector is intended for the return of neutrons to the charge, i.e., it contributes to an increase in the coefficient of the use of the fissionable material.

The shell of warhead is made of durable steel in order to avoid the possibility of splitting the monolithic pieces of fissionable material into the small pieces with the mass less than the critical.

The effect of explosion it is accepted to estimate by the value of the TNT equivalent, i.e., by that quantity of trotyl which during the explosion of conventional explosive would give the same effect.

The exploded in the postwar period atomic charges depending on bore had the TNT equivalent from several thousand to hundreds of thousands of tons.

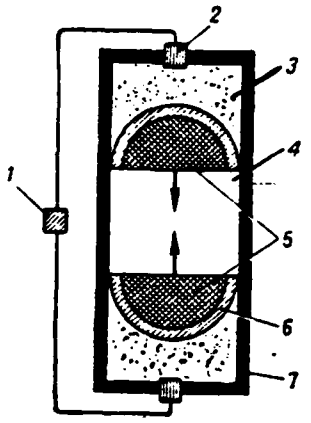

Fig. 18. The schematic diagram of the device/equipment of the atomic warhead: 1 - mechanism of remote/distance or percussion; 2 - detonators of explosive; 3 - charge of usual substance; 4 - cavity, from which is evacuated the air; 5 - atomic charge; 6 - neutron reflector; 7 - shell.

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During the atomic explosion appears glaringly the bright flash/burst, which even in the clear solar weather lights up vicinity to tens of kilometers.

Following the flash/burst is formed the fireball, well seen from the large distance. Rapidly increasing and being built up upward, it is gradually converted into mushroomcloud by height/altitude into

several kilometers.

The explosion of atomic charge is accompanied by shock wave, luminous radiation, penetrating radiation and radioactive contamination of locality. Shock wave will deposit enormous mechanical decomposition, and luminous radiation can cause large fires. Penetrating radiation of neutrons and gamma-rays is disastrous for the living organisms.

The colossal energy, which is isolated during the explosion of hydrogen or thermonuclear charges, appears as a result of the formation of the more heavy nuclei of helium atoms from the light atomic nuclei of hydrogen isotope.

Thermonuclear warheads possess even larger destructive properties.

In the foreign press it was communicated that the thermonuclear charge with the TNT equivalent into 20 megatons causes decomposition in a radius of approximately 16 km.

Atomic and thermonuclear charges apply in the air-to-surface missiles, that have the range in several hundred kilometers.

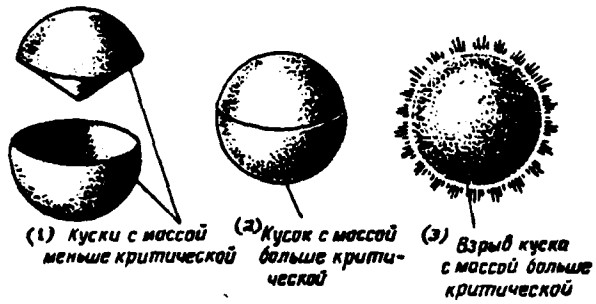

Fig. 19. The diagram of obtaining atomic explosion with the compound of two pieces of fissionable material each of which has a mass, only smaller than the critical.

Key: (1). Pieces with the mass less than the critical. (2). Piece with super-critical mass. (3). Explosion of piece with super-critical mass.

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In the tactical missiles utilize the usual warheads, which according to their designation/purpose can be explosive, HE fragmentation, fragmentation, ignition and cumulative.

The explosive, fragmentation and HE fragmentation heads of air-to-surface missiles in principle barely differ from the heads, used in the previously air-to-air missiles examined.

Ignition warheads are equipped with the chemical substance which is dispersed during the explosion and burns by strong flame, developing in this case temperature to 2000°C. As the incendiary mixture utilize the alloys of magnesium, thermite mixtures, phosphorus, and also hardened gasoline or petroleum.

Incendiary charges usually are manufactured in the form of the magnesium cylinder, filled with the thermite mixture (oxide of iron and aluminum). The ignition of the thermite mixture is produced with the aid of the fuse, which igrites powder or powder of magnesium, which ignite thermite mixture.

Sometimes ignition warhead they equip with a small quantity of conventional explosive. It is intended for the dispersion of the burning elements/cells of head over definitely the area.

For the decomposition of the armored targets are applied the warheads with the shaped charge. In this explosive charge is given special form, which makes it possible to concentrate explosive energy in the required direction.

Fuses of air-to-surface missiles.

The blasting/detriment of the warheads of the majority of the samples/specimens of the rockets of the class in question is produced with the aid of the relatively simple impact fuzes which consist of a capsule-detonator, striker and mechanism of preservation.

During rocket flight the shock worker is situated in the rear position, at the moment of the encounter of rocket with target the striker continues to move over the inertia and pricks a capsule-igniter which undermines detonator. The latter causes the detonation of the main charge of warhead.

Sometimes are applied impact fuzes with the delay/retarding/deceleration, this makes it possible for rocket to penetrate in the target at the specific depth, and then to explode.

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Depending on that, where is produced the blasting/detriment of atomic warhead - underground (water), on the earth's surface (water) or in the air at the height/altitude of several hundred meters - explosions are subdivided into the underground ones (underwater), the ground-based ones (above-water) and the air ones; these explosions

are characterized by different degree of contamination of locality.

For the blasting/detriment of atomic charge on the earth/ground can be used usual impact fuzes which provide the inflammation of powder in the head. Formed in this case gaseous products collide the noncritical masses of atomic charge, which causes its chain reaction. The underground blasting/detriment of atomic charge can be produced with the aid of the impact fuze with the delay/retarding/deceleration.

For the blasting/detriment of atomic head in the air are utilized the radio altimeters or the barometric altimeters, which are the measuring elements/cells of proximity fuse.

The basic element/cell of the barometric altimeter, which fixes a change in the atmospheric pressure, is aneroid or the bellows, from which is evacuated the air.

Aneroid is placed in the airtight chamber, connected with the aid of the conduit/manifold with the receiver of the statistical pressure, carried out to the surface of the warhead of projectile.

With the aneroid is connected the thrust, which sets to the motion the wiper. With a reduction/descent in the rocket to the

required height/altitude at the potentiometer appears the electrical signal of the corresponding value, which includes the electrical destruct circuit of conventional explosive, which in turn, produces air atomic explosion.

In the radio altimeter for measuring the height/altitude is utilized the transceiver equipment, which works in the pulse or continuous duty. Upon the reaching/achievement by the rocket of the necessary height/altitude occurs the inclusion/connection of the electrical target of the blasting of charge.

Power supplies actuators.

Entire used in the guided missiles radio-electronic equipment consumes electrical energy.

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For the work of equipment are applied battery power-supply systems with the converter of alternating current. The characteristic feature of converters is high frequency stability and stress/voltage, attained with the aid of the special regulators.

In the guidance equipment of rockets the electrical error signal

must be intensified and ccnverted into the mechanical motion of the corresponding control. This task makes the actuator.

Apply several methods the energy transfers to the load of the system of control - electrical, pneumatic and hydraulic.

In the electrical transmission systems of energy as the actuators utilize the electric mctors of direct or alternating current.

Fig. 20 shows the diagram of the actuator in which is used the electric motor of direct current. To the input of the excitation winding of generator is supplied the intensive error signal. Depending on value and sign cf this error signal in the generator is produced the corresponding stress/voltage which is supplied to the armature of electric motor.

In connection with the fact that the excitation winding cf direct-current motor is excited by the independent source, the direction of rotation of armature is determined by the polarity cf the produced by current generator, and the speed of rotation - by its value.

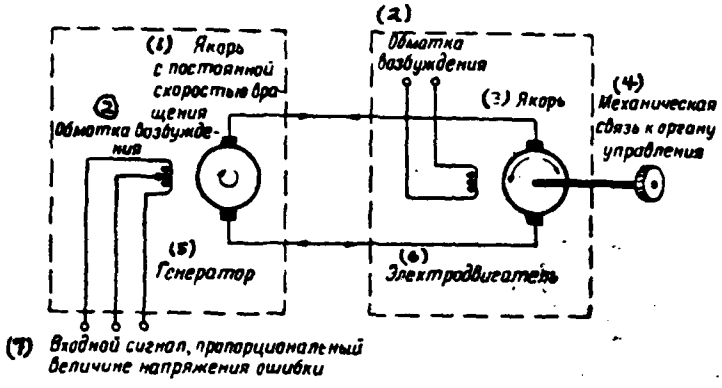

Fig. 20. Schematic diagram of the electric motor of the direct current, utilized as the actuator.

Key: (1). Armature with the constant velocity of rotation. (2). Excitation winding. (3). Armature. (4). Mechanical connection/communication to control. (5). Generator. (6). Electric motor. (7). Input signal, proportional to value of error voltage.

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The electric motor, mechanically connected with the control, produces its displacement/movement in the necessary direction.

The work of hydraulic drives is based on the uniform transfer of external fluid pressure. Hydraulic systems include the pressure pumps, controlled by electric motors, reservoirs, bypass valves and

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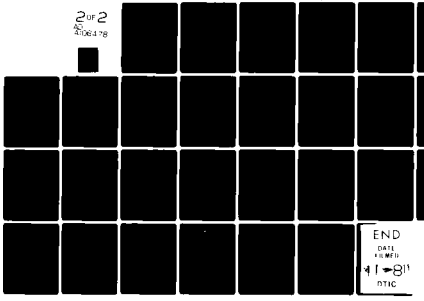

other elements/cells.

In the pneumatic system is utilized the located under the large air pressure. This system consists of reservoir with the compressed air, conduits/manifolds, air relay, elements/cells of mechanical connection/communication and other parts.

In the guided missiles there are many other mechanical and electro-radiotechnical elements/cells (contactors, electronic amplifiers, solenoids, timing devices, etc.), which in their device/equipment and designation/purpose are analogous to these elements/cells in many types of the guided missiles.

Chapter III.

PRINCIPLES OF THE COMBAT EMPICYMENT OF AN AIRCRAFT ROCKET WEAPON OF CLASS AIR-TO-AIR AND AIR-TC-SURFACE.

Combat missions, made by fighter aviation.

Fighter aviation is utilized for the cover of the troops and objects from the air strikes and pilotless air attack weapons of the enemy, and also for dealing with the air reconnaissance aircraft. These tasks are made in interaction with the ground-based or ship air defense weapons.

The cover of objects in the interior of the country is accomplished/realized in essence via flights from the airfields to the interception of the aerial targets.

In the frontal zone the fighters carry on a struggle with the air enemy both on the approaches to the front line and in the depth

of their combat groupings. Fighter aviation is applied for the interception of the bombers of the enemy at different heights/altitudes, it carries on a struggle with the pilotless air attack weapons and the ballcers.

In the second World War the interception of air enemy under front conditions often was made from the holding areas, they were which they were located above the location of the enemy or the location of its troops.

Fighter aviation is utilized also for the cover of ships in sea and the naval bases.

Fighters can accompany others of the air arm in flight for the elongation/extent of entire route, in the individual sections or in the combat area.

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In the latter case of the group of fighters they arrive into the combat area of earlier than the provided aircraft and carry on a struggle with the fighters of the enemy.

The specially chosen parts and the subdivisions of fighter

aviation are drawn for the cover of their home airfields.

One of the important tasks, laid on fighter aviation, is fight with the airborne troops of the enemy. Fighters can eliminate landing aircraft on the route of their flight, in the area of debarkation or drop of landing, strike landing on the earth/ground, and also provide the combat operations of the bombers, which deliver impacts/shocks on the airborne troops.

Fighter aviation can also be drawn, also, for conducting the aerial reconnaissance in the interests of Air Force, ground forces and fleet.

In the interests of VVS the fighters find out air defense system, airfields and separate units. Aerial reconnaissance is conducted in pairs by fighters, as a rule, by means of photography and visual observation.

For the fleet the fighters find out the sea and coastal targets of the enemy, for ground forces - concentration of hostile troops, their movement along the roads, and also is established/installed the presence of bridges and crossings in the water obstacles.

In the course of combat operations multipurpose fighters are

drawn for the damage/defeat of the important, well disguised objects, such, as the positions of rocket and cannon-type artillery, tanks and armored carriers, radars, control centers, train, bridges and the troop concentration. Consequently, multipurpose fighters can be drawn for the damage/defeat both of air and ground targets.

The flights of fighter aviation for the support of ground forces are produced according to the previously developed plan/layout in which are determined objects of damage/defeat and action time. Fighters can be located on the airfields in the readiness for the actions for the application of impacts/shocks on the suddenly appearing targets.

Fighter aviation can be used for the holder-up of its airborne troops.

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Before drop or airborne landing preliminarily and in the course of landing is made the aviation preparation for landing and the suppression of the air defense weapons of the enemy in the line of traffic of transport aircraft.

With accomplishing of the aviation preparation for landing the

basic objects of the actions of fighter aviation can be the tanks, rocket installations and troops, which lead combat with the landing or advanced from other areas.

During the fight with the airborne troops of the enemy the fighters are drawn for the destruction of his cargo fleet and landing parts on the initial airfields, in the air and in the area of landing.

Fighter aviation can carry on a struggle with the amphibious forces. In the coast defense the fighters are utilized for the immersion of transport vessels on their approach to coast feature, eliminate troops and amphibious means at the moment of landing of paratroops and in the course of combat operations.

Combat employment of the unguided and controlled air-to-air missiles.

Contemporary fighter-to-fighter air combat, armed by rocket weapon, differs from the dogfights, which occurred in the period of the second world war.

The successes, achieved in the aeronautical development and rocket armament, make it possible for fighters to conduct combat operations at different heights/altitudes, in the daytime and at

night, under simple and severe weather conditions.

Interception by the fighter of high-altitude high-speed bomber is complex problem, since fighter does not always have speed advantage in comparison with the speed of bomber. Furthermore, the ground radar of detection and induction/guidance for a number of reasons can belatedly reveal/detect target and derive on it fighter-interceptor.

Statistics shows that the probability of the interception of bombers in the past world war was approximately 30o/o. In this case only in 16c/o of cases was opened/disclosed the firing and 10o/o of attacks were successful/fruitful. These indices were considered as the very successful.

Since then the fighter-interceptors underwent qualitative changes, and radars of interception became automatic radio sights. For the armament of fighters entered the air-to-air missiles. Bombardment aviation in the process of its development also underwent qualitative changes.

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The probability of the interception of high-speeds bomber, in

the opinion of the foreign specialists, actually increased insignificantly. From experiment of the numerous studies, carried out abroad, it follows that the contemporary subsonic fighter-interceptors at the height/altitude to 12-15 km intercept 30-40o/c of the crews of the attacking forces.

Actions on the high-altitude targets (it is more than 15 km) are less successful/fruitful. There are no data about the percentage of shoot-down of high-speeds bomber at present. It is assumed that in the future war the fighter-interceptors will shoot down not each intercepted bomber, but only certain part of them.

Air-to-air missiles raised the probability of the destruction of bombers, since they transport a considerably larger quantity of explosives, and the guided missiles, furthermore, they are guided to the target with the larger precision/accuracy. However, the damage/defeat of bombers by rockets is the consisting element/cell of dogfight.

The takeoff of fighter to the interception of the manned or pilotless target will precede its detection with the aid of the ground radar of detection and induction/guidance.

The maximum time of warning/prevention about the appearance of a

target depends on the characteristic of radars, places of their arrangement/position, height/altitude and flight speed of bomber.

Fig. 21 gives the graph, which shows the dependence of the maximum time of warning/prevention on the speed and flight altitudes of bomber. This dependence is constructed for flight altitudes of target from 30 to 1.5 km taking into account the theoretically maximum range of the ground stations of detection.

From the graph it is evident that the subsonic bombers can be detected depending on flight altitude in 15-25 min to their approach to the location of radar. Supersonic bombers, in spite of an increase in altitude of their flight, they can be discovered in 10-20 min. For this limited time the fighter must take off, collect height/altitude, reveal/detect, intercept target, conduct with it combat and destroy target to its approach to the defended object.

Let us examine the case of attack by the fighter of bomber from the rear hemisphere.

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Practice shows that command/crew to the lift of fighter the alert pilot obtains not immediately, but through several minutes. This time

is necessary to the target identification, making of decision to the interception, the transfer and the passage along the lines of communications of command/crew to executor/performer.

The fighter, which pcssesses flight speed 1200 km/h, reaches the height/altitude of 15 km approximately/exemplarily in 7-9 min.

Usually fighter-interceptor is derived/concluded into the rendezvous area with the bomber at a distance of 120-160 km from the covered object. To this flight it will be required by already 6-8 min. Consequently, for conducting the dogfight pilot will have available only 7-12 min, for this time it is necessary to reveal/detect target by onboard radio sight, to overtake, to take aim and to shoot down it. Fire/light on the target by rockets "air - air" is usually opened/disclosed from the distance of 1-2 km.

With the excess of the speed of the fighter above the speed of bomber in 200 km the operation/process is overtaken it will engage about 3-4 min.

Consequently, report "Target I see, I attack" precedes the very stressed work of the calculation of the control post and crew of the aimed interceptor.

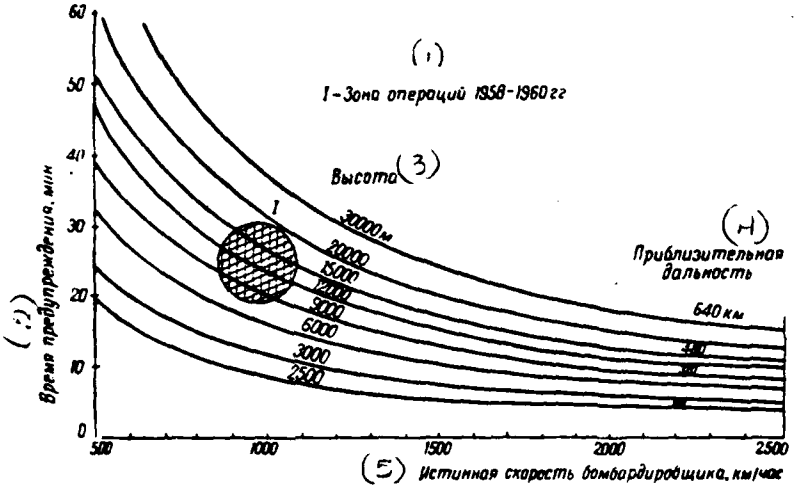

Fig. 21. Maximum time of warning/prevention, provided by search radars for the aircraft with different speeds and by design altitude.

Key: (1). I - zone of operations/processes 1958-1960. (2). Time of warning/prevention of mines. (3). Height/altitude. (4). Approximate distance. (5). True airspeed of bomber, km/h.

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With the least error in the work of any of these components/links the target can be passed.

If one assumes that the approaching the defended object bomber at a distance to 65-100 km is not yet fired and its crew will do entire possible so as in the latter/last phase of flight not to be

biased/beaten (but this it is pcssible to avoid due to the skillful maneuver or the use/applicatien of radio interference), then it is completely obvious that there is a real prcbability of the breach/inrush of bomber to the cbject of bcmbing.

Let us assume that took place the successful interceptor control to the target, and let us trace the latter/last stage of interceptien - dogfight.

After revealing/detecting cn the indicator of radio sight mark from the bomber, fighter pilct begins to ccnverge with the target. In the complete darkness when befcre its eyes flicker only numerous instruments, without seeing target and being oriented toward it by the flickering mark on the indicator, fighter must be drawn together with the bomber.

As soon as they will be drawn togathar to the distance of firing, will occur the "capture/grip" of target; further cutcome of dogfight is solved automatically. Fighter pilot presses trigger button - shudders machine frame. The accustomed to the darknass eyes of pilot to the instant blinds bright flash/burst from the included/connected jet engine cf the guided missile or several sclid propellant engines of the unguided rockets.

The preliminarily prepared to the start guided missile is guided to the target on the invisible radic beam or on the commands/crews of self-homing head. Through several seconds in front of the interceptor appears bright flash/burst - bomber (or winged winged missile) is destroyed.

Thus, air-to-air missiles are sufficiently powerful/thick contemporary aircraft weapon. The kill probability of the target of each of such guided missiles many times exceeds the effectiveness of the firing aircraft cannons or machine guns.

In the night dogfight, in the opinion of the foreign specialists, will be used the rockets, aimed with the aid of the radar guidance systems and equipped by infrared self-homing heads which are especially convenient for the aerial gunnery from the rear hemisphere.

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The high-thrust jets of bomber are the stable source of infrared radiation to which will be accurately derived/concluded each projectile.

It is considered that [illegible] the construction by reliable PVO of

some air-to-air missiles it is insufficient.

In this case the target was biased/beaten literally for several ten kilometers to the covered object.

In the transient night dogfight is feasible the case, when the crew of bomber uses radio interference or fulfills the unexpected energetic anti-fighter maneuver, i.e., it will not make possible to fighter to take aim. Under these conditions the target can be fired or even not at all discovered by radio sight.

Practice shows that to the repeated interceptor control, that flies at high speeds, will be required still several minutes during which the crew of bomber can accomplish its task.

Stern attack of the supersonic bomber always cannot end successfully to the output/yield of bomber to bomb-release line.

Taking into account shortcomings in stern attack, American designers developed the sufficiently complicated equipment, which makes it possible to intercept and to strike the aerial targets in the crossing courses.

This method of interception is based on the use of calculators

and automation of the operation/process of interception and requires increase in the precision/accuracy of the conclusion/derivation of interceptor by the bomber, since the insignificant error in the course plotting of target can lead to the disruption/separation of interception.

Let us assume that with the aid of the ground radar the interceptor is accurately derived into target area at angle of 90° to its course. Radar of interceptor must reveal/detect target and take it, from this point on, ground-based equipment ceases to control/guide the flight of fighter.

In the process of target tracking the airborne radar determines the data about its position, distances and speeds and transfers them to the airborne computer which produces basic firing data.

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At the necessary moment/torque occurs launching/starting the guided missile, which will strike target with the large probability, if enemy does not undertake radio countermeasures.

Some foreign specialists confirm that the interception in the crossing courses does not solve radically the problem of the

interception of high-speed/high-velccity aerial target. Calculators increase the probability cf interception; however, the well prepared crew of bomber under specific ccnditions can exclude the use/application of rockets cr lower their effectiveness.

The important means, which complicates a precise conclusion/derivation cf interceptor to the target, is the maneuver of bomber in the speed, the height/altitude and the direction. By the force of the discrete/digital reading of target present-positions datum by ground-based radars the error in the coded commands/crews, transferred to the interceptor from the earth/ground, with its guidance to the target will grow/rise in the case of the maneuver of bomber. This as the final result can lead to the loss by the interceptor of target.

The task of the interception of the aerial targets in the head-on courses is the destruction cf bombers at the considerable removal/distance from the defended objects.

The complexity of problem consists in the fact that even during the detection cf bomber radic sight at the removal/distance in several ten kilometers the total rate of closure of interceptor and bomber will be so it is great, that the pilot of fighter will have at his disposal too little time for the aiming.

In addition to this the tctal flight speed of target and interceptor, equal to 4M, is the limit of tha psychophysical possibilities of the lccated in the aircraft person. Under thesa conditions the pilot is capable tc distinguish object/subject only in the cone with angle of 15°.

The measures for the ccunteraction of bombers to the fighter-interceptors, armed by air-to-air missiles, can be anti-fighter maneuver, raid cf the fine/small groups cf bcmbers in the appropriate combat formaticns and wide applicatiоn of radar clutter.

The applied in the Seccnd wcrld war anti-fighter maneuver, in the opinion of the foreign specialists, thus far still it remains the efficient means, which considerably complicates the task of interception.

Thus, the timely corrective turn of bomber into the side of fighter converts interception in the crossing courses into the barely effective interception in the head-on courses.

With the timely facing of bomber to the side from the fighter the interception in the crossing courses will become interception in the identical courses. Under these conditions it is overtaken target it can occur out of the zone of action of the ground radar of induction/guidance.

In field conditions with the breach/inrush of the defense of enemy should be expected the considerable density of raid from one either several directions when per unit time to the assault objective will emerge a maximally possible quantity of single bombers or fine/small groups, which, in the opinion of many specialists, can considerably hinder/hamper the counteraction of defender.

The command of PVO, without having the capability under these conditions, especially at night, to use simultaneously many

interceptors, will forced the part of the targets leave without the counteraction. Furthermore, the use/application of radar clutter at the high density of raid will prove to be considerably more effective.

In the foreign press it was repeatedly indicated that the use/application of infrared homing systems forges the combat employment of air-to-air missiles by the limited region of the basic thermal radiation/emission of each target. As is known, the large part of the thermal radiation of contemporary aircraft is directed to the rear hemisphere.

Furthermore, the range of infrared homing system depends on meteorological conditions, time of days, direction of attack with respect to the sun and to the longitudinal axis of bomber. Therefore the guided missiles with the thermal heads will be in essence used only for the firing night, also, at the high altitudes, since such conditions are best for the work of infrared guidance systems.

The use/application of air-to-air missiles will not ensure the reliable damage/defeat of bomber at night or under severe weather conditions at the height/altitude below 1-1.5 km.

Use/application in the air-to-air missiles not usual, but atomic charges will considerably raise their effectiveness. In the foreign press it was communicated that with the blasting/detriment of the atomic head of the projectile "Genie" all aerial targets at a distance to 500-800 m from the burst center will be destroyed.

However, even use/application of atomic charges in the rockets of the class in question, in the opinion of the foreign specialists, cannot guarantee interception and destruction of all aerial targets by all-weather interceptors, since the firing these means precede such complicated elements/cells of dogfight as induction/guidance, approach and the "capture/grip" of the targets which not always can be in proper time and successfully fulfilled. Therefore a sharp increase in the effectiveness of the warhead of air-to-air missile, based on the use/application of atomic charges, is important, but not basic factor.

After examining the special features/peculiarities of the dogfight between the interceptor, armed by air-to-air missiles, and the bomber, it is possible to draw the conclusion that it is not possible to previously predict the outcome of the fight between that defended and that attacking sides.

The equipment of fighters with air-to-air missiles to the certain degree strengthened them; however, this weapon does not make it possible to eliminate with the required probability of air weapon system, since the combat characteristics of the latter also strongly increased.

Combat missions, made by bombardment aviation.

Bombardment aviation is the independent kind of Air Force. It is intended for the application of the powerful/thick impacts/shocks into the short time interval on different objects of enemy.

Contemporary bombers possess the long range of action and are applied for the damage/defeat of diverse objects both on the field of battle and in the deep rear.

The important object of the combat operations of tactical bombardment aviation are hostile troops which on the field of battle usually are placed in different engineering structures (trench,

shelters, the passages of communication, etc.), and also rocket installations/settings up and the firing positions of artillery installations/settings up.

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Under contemporary conditions to tanks is assigned large role both with the offensive ones and during the defensive operations. Bombers are capable of delivering impacts/shocks on the tanks, which are found in the shelters or in the motion.

From experiment it is known that to the successful combat operations of its ground forces contributes the disorganization of control by hostile troops. Bombardment aviation will be always drawn for destruction or suppression of command and observation posts, staffs, centers of communication of enemy and other technical means of control.

Bombers can deliver impacts/shocks by the railroad junctions, the stations, the rolling stocks with the troops and the loads, on the bridges on the highways or on troops' accumulations in the crossings through the river lines.

Under contemporary conditions the tactical aviation is drawn for

the application of impacts/shocks on the storages and warehouses with the ammunition, the combustible and various technico-material means. Storages in the army and army rear usually are placed large area and are masked well.

Fight with the air weapon systems of the enemy is the most important task of belligerents. Bombers will deliver impacts/shocks on the airfields and the launch pads of rocket weapon.

If ground forces act in the coastal zones, then tactical bombardment aviation will act sea communications of the enemy and eliminate combat ships and ships on the bases and in sea.

Under the effect of the great successes in the aeronautical development and atomic weapon in some capitalist countries wide acceptance received the views about that leading it swarmed in modern war of Air Force and rockets of different classes.

For example, in the USA is officially proclaimed doctrine about the leading role in modern war of "air-atomic power". From this air doctrine it follows that combat aviation of VVS, first of all strategic aviation and intercontinental rockets, will make it possible to destroy the vital objects of the enemy, composing basis economic and military powers of state.

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As the most important objects in the depth of the state of the enemy are considered military-political centers, areas/sites for the starting/launching of intercontinental ballistic missiles, aviation and sea bases, storages of atomic weapon, largest power stations, which lead industrial areas, etc.

The prominent representatives of American and English VVS confirm that strategic aviation best anything can utilize nuclear weapons and within the shortest periods blow up the economic and war potential of the enemy.

Foreign specialists consider also that the replacement of the manned aviation by rockets, in spite of the fact that a quantity of entering the armament rockets continuously grows/rises, will occur gradually; it will pass still much time before this weapon it will extrude/exclude the supersonic manned aviation.

Large hopes abroad are laid for the use/application of the long-range guided missiles and aircraft ballistic air-to-surface missiles, intended for the damage/defeat of the important objects of

the enemy, well shielded by contemporary air defense weapons.

Combat employment of the unguided and controlled air-to-surface missiles.

Overcoming contemporary system of PVO in the theater operations or in the depth of the state of the enemy is considered as the complex problem whose success is determined by many different factors, including by completeness of prospecting the objects of the enemy, by tactical-technical characteristics of aircraft and their armament, by combat training of crews.

The combat employment of air-to-surface missiles will precede careful aerial reconnaissance. Each reconnaissance aircraft under contemporary conditions is considered as the potential carrier of atomic weapon; therefore enemy will try by the methods of every kind him to destroy.

During some studies abroad the aerial reconnaissance of objects in the tactical and operational depth was conducted by the reconnaissance aircraft which depending on the situation of lethal

factor at the low, average/mean and high altitudes.

To each found out target it was provided for to three aircraft departures.

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The night prospecting of objects often was made at the low altitude. In the area of object flight altitude increased, object was photographed or was examined/scanned several times, approaches to it usually were done from different directions.

Radar guidance systems of AA guided missiles and radar equipment of the induction/guidance of fighters of PVO were detected with the aid of bomber type special reconnaissance aircraft, equipped by reconnaissance radio equipment.

Under contemporary conditions was eliminated the need in the concentration of a large quantity of bombers for the decomposition of important objects in the theater operations and in the interior of the country of enemy.

In recent years the aviation during the studies, as a rule, acted by the fine/small groups, which consist of several aircraft.

With the breach/inrush tc the well shielded objects the aircraft of tactical aviation accomplished low-altitude flights.

In the course cf the holder-up of ground forces the fighter-bombers, armed by the unguided and controlled air-to-surface missiles, can eliminate small size mobile and fixed targets, such as tanks, armored carriers, trains, the launching sites of rocket installations/settings up, radars, control posts, troops in the motion and in the assembly areas.

Fighter-bombers fire small size mobile and fixed targets by rockets from the low altitudes.

As is known, is for the first time concentrated unguided air-to-surface missiles were used in the Great Patriotic War with the battle in Volga. Our aviation, storming the forces and equipment of the enemy, inflicted enormous losses on enemy. These successes drew the attention of the military specialists cf many countries and contributed to further develcpment of air-to-surface missiles.

Possessing high maneuverability, fighter-bombers with the bombardment by the rockets of the pinpoint targets for achievement of

rapidity can extensively use horizontal and vertical maneuvers.

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During the studies, carried out in the series/row of states, it was established/installed, that the fighter-bombers, which make raid at the low altitude and high speed, successfully can burst open to the prescribed/assigned objects.

The high precision/accuracy of the firing rockets makes it possible for agressor to apply the small on the number groups of fighter-bombers. For achievement of rapidity the strikes can be deposited at the broad front.

The characteristic tactical special feature/peculiarity of multipurpose fighter-bombers is the fact that they can conduct independently dogfight after the damage/defeat of small size ground (above-water) targets by air-to-surface missiles. Consequently, the multipurpose fighter-bombers, armed by air-to-surface missiles and "air - air", do not need fighter cover.

In the series/row of studies multipurpose fighter-bombers were used for harassing of fighter air defense aviation of defender and disorganization of its actions. In the zones of the detection of

radars of the enemy repeatedly appeared the fine/small groups of the aircraft which immediately after the takeoff of interceptors departed to their airfields. Such frequent false raids caused the increased expenditure/consumption of the aircraft departures of fighter air defense aviation of enemy.

Combining the distracting false and real raids, agressor attained that to the outlined for the impact/shock targets burst open the specially chosen fine/small groups of multipurpose fighters.

The strategic bombers during all studies usually acted without the cover and were delivered the impacts/shocks by fine/small groups into 4-5 aircraft. Distance on the time between the groups of 9-11 min, and between the aircraft - 1-2 min. Flight altitude of 12-15 thousand m.

Let us pause at some special features/peculiarities of the use/application of the controlled air-to-surface missiles, that possess the range in several hundred kilometers and guided to the target with the aid of the inertial guidance system.

As is known, sensing elements of inertial guidance system are the accelerometers which are intended for measuring the accelerations of rocket. Passed by rocket way is calculated as a result of the

continuous dual integration of accelerations in the phase of flight between the target and the carrier aircraft.

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But what, in the opinion of the foreign specialists, are the real possibilities of a precise hit by the long-range controlled air-to-surface missile?

Contemporary strategic bombers have available diverse navigation aids; however, in flight above the territory of the enemy crews will as far as possible avoid the use/application of panoramic radar sets and means of distant radio navigation. Otherwise show/render the active electronic countermeasure.

It is known that the visual orientation during the night flight of the strategic bomber is strongly hindered/hampered, and under the bad weather conditions generally it is eliminated. Consequently, its flight above the territory of the enemy can be checked in essence by the means of astronavigation, and for a precise orientation must periodically be included panoramic radar set.

For position finding of aircraft with the aid of the means the astronavigation use the method of measuring the heights/altitudes of

two or more than stars, in this case are always corrected for parallax, refraction, dip of the horizon, for the semidiameter of the sun or moon. However, even the most precise introduction of all corrections does not eliminate the sufficiently essential errors in the determination of moving coordinates of bomber.

From the affirmation of the foreign specialists, the accumulated error in position finding of aircraft during the use/application of means of astronavigation reaches to 15-20 km.

Furthermore, the measurement of speed and wind direction in flight of bomber out of the ground visibility will be made also with the error. After rocket launching wind force will be reflected also in the precision/accuracy of its induction/guidance. Finally, is possible the effect of the local gravity anomalies which can influence the work of gyro instruments and the precision/accuracy of the firing the guided missiles.

All this will cause considerable errors at the target of the rockets, aimed with the aid of the inertial guidance systems. In connection with the relatively low accuracy of guiding rocket to target usual warheads will be used as exception/elimination, since atomic and thermonuclear heads to a certain extent compensate vectoring errors.

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All long-range air-to-surface missiles after start must complete the sufficiently endurance flight above the territory of the enemy, that it does not eliminate the possibility of their incidence/impingement into the zones of the attainability of AA guided missiles. Taking into account the considerable geometric dimensions of the controlled air-to-surface missiles and the relatively larger value of their effective reflecting radar surface, foreign specialists allow/assume the possibility of the destruction of the guided missiles by surface-to-air missiles.

The essential shortcoming, which lowers the effectiveness of the combat employment of rockets of the type "Rascal" and "Hound Dog", are their large sizes/dimensions and weight. As it was noted, the transportation of these rockets was possible only with the external suspension. Consequently, the maneuverability capabilities of the bomber, which carries actually one - two large aircraft, will be considerably lowered. This increases the probability of interception by the fighter of carrier aircraft before its approximation/approach to a border of missile takeoff.

One of the means, which impede to defender the destruction of aircraft - the rocket bearer of class "air - the earth/ground", is the use/application of different decoy targets which can be thrown off from the bomber at the moment of its attack by interceptor. Decoy targets can also distract to themselves surface-to-air missiles.

As it was communicated in the foreign press, the effectiveness of the setting of passive jamming X of bombers B-52 is depressed because the dipole reflectors always lag behind the directed aircraft. For the elimination of this shortcoming in the USA are developed/processed small stores with the rocket projectiles which are intended for the ejection of metallic bands or reflectors of another type in front of the strategic bombers.

In order to increase the probability of overcoming the air defense weapons by strategic aviation, some foreign specialists propose to combine bomber raids with the raids of winged surface-to-surface missiles.

There is an opinion that if the attack of cruise missiles on the time and the targets will be matched with the attack of bombers, then the latter will obtain the series/row of the advantages, which facilitate accomplishing by them combat mission.

In particular, it is indicated that the flying in front of the bombers cruise missiles can be used for the decomposition of the objects of PVO of enemy and can also be used for dealing with the radar equipment of enemy.

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The experimental starting/launching of aircraft ballistic missiles from the American manned bombers showed that this weapon is very promising.

Some foreign specialists consider that the flying bases for the starting/launching of ballistic missiles will give in the future of strategic aviation such important advantages as dispersed nature, mobility and the flexibility of use/application.

In the foreign press it was noted that the long-range aircraft ballistic missile has a series/row of advantages before the rocket, started from the earth/ground. For example, aircraft to rocket to more easily re-aim, than the rocket of any other system of ballistic arms. To make a decision about the starting/launching of ballistic surface-to-surface missile is considerably more difficult than about the flight of the manned bomber, armed by ballistic missile.

Foreign specialists emphasize that the aircraft - the carrier of long-range ballistic missile can pass the significant part of the way

to the side of the enemy, and then him it will be possible to recall back/ago after the refinement of situation, which is completely excluded in the case of applying the intercontinental ballistic missiles, started from the earth/ground.

Majorities of previously examined air-to-surface missiles intended for the damage/defeat of ground targets, it can extensively be used for the firing at the above-water and underwater waterborne targets.

After appearance on the shield of panoramic radar set of the on duty reconnaissance aircraft of marks from the ships and vessels of enemy the defender will build up into the air the bombers, armed by long-range rockets.

The outcome of the duel between bombers and ships of enemy will be determined by strength ratio, used in combat, by quantity of built up into the air bombers, by the presence aboard the ships of the antiaircraft missile systems, by a quantity of fighter-interceptors, etc.

In view of the technical complexity of organizing the uniformly strong ship air defense the part of the bombers under specific conditions will be able it to overcome, since a large quantity of

dispersed ships and ships will represent tempting targets for the bombers, armed by the rockets of class "air - the earth/ground (surface)".

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Carrier-based fighter-interceptors under severe weather conditions cannot simultaneously intercept all bombers, which accomplish the clearly planned raid from the different directions.

With a large quantity of aircraft in the air on the indicators of the ship radar of induction/guidance will be examined/scanned a considerable quantity of brightness marks.

It is obvious that, the more complicated air situation, the more difficult calculations of ship control posts correct to distribute the targets between the fighter-interceptors. Even with a good training of operators are unavoidable such errors, as the passage of targets, induction/guidance to their aircraft, guidance to one target of several interceptors, etc.

For dealing for the waterborne targets the bombers can employ the rockets, controlled with the aid of the majority of the existing guidance systems and homing, with exception of inertial system, which

does not consider the motion of target.

The concentrated starting/launching of a large quantity of rockets, which start simultaneously from different aircraft, creates severe conditions for PVO of the group of ships.

The guided missiles can be used also for dealing with the submarines of enemy, which are located in the above-water position. For this are applied the rockets, intended for the damage/defeat of small ships or pinpoint targets.

Fight with the not immersed submarines for the aircraft - rocket bearers does not present great difficulty, since the submarines do not have powerful/thick air defense weapons. If the crew of boat in proper time reveals/detects the aircraft of enemy and will have time to ensure its rapid insertion to the launching of rocket, then the submarine will survive.

In the opinion of some foreign specialists, for the destruction of the submerged submarines can be drawn the aircraft and the helicopters, armed by the special rockets, which are the combination of the unguided rocket and homing torpedo.

It is obvious that the use/application of these rockets will

precede submarine detection. The extended methods of submarine detection consider visual observation from the air, use/application of hydroacoustic equipment and measurement of the local disturbances of terrestrial magnetic field.

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The probability of the visual detection of the submerged boat depends on the time of days, meteorological conditions, character of agitation, submersion depth, contrast with the sea bottom, etc.

In the series/row of fleets wide distribution received the sonobuoys with the necessary onboard equipment on the aircraft, and also magnetic feelers. The effectiveness of the use/application of buoys depends on the hydrological conditions of sea and noise level of the submarine.

For submarine detection with the aid of the means of hydroacoustics it is necessary that the boat would traverse audibility zone of buoy, i.e., so that in the course the motions of the submarine would create barrier of these means or would surround by its closed duct/contour of the buoys.

The sonobuoys are equipment for single action. The buoys,

discarded around the mobile boat, will prove to be useless, when it oversteps the limits of their action. Taking into account the complexity of this antisubmarine search, in some fleets this problem they solve with the aid of the helicopters, from which into the water lower the towed sonar.

All existing methods of the detection of the submerged submarines require the enlistments of the well trained operators, capable of distinguishing the diverse phenomena, disclosing the submarine, from the similar phenomena, which occur on other reasons.

After the detection of the submerged submarine in the area of its location will be caused the aircraft - carrier of special rockets. At the necessary moment/torque from the aircraft starts the rocket, which can be aimed at the underwater target with the aid of the combined guidance system. On one of the foreign rockets its lateral guidance is produced with the aid of the radio commands, and flight altitude is corrected by radio altimeter.

With the approximation/approach of rocket to a target to the range of guidance equipment from it automatically will be separated/liberated all inherent in rocket elements/cells (wings, controls, accelerator), and the homing step/stage will be immersed into the water and will be drawn together with the assault objective

independently. The damage/defeat of the submerged boat will occur as a result of the underwater explosion of warhead.

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To conquer in modern war is possible only by the joint efforts/forces of all branches of the armed forces. The value of each form of the armed forces and arm of service will be determined by the specific conditions of the armed fight.

Experiment of the Second World War and further development of combat aviation in the postwar period confirmed that Air Force at present occupy the important place in the general/common/total system of all branches of the armed forces.

However, even possibility of the concentrated use/application in VVS of long-range air-to-surface missiles, equipped with atomic and thermonuclear charges, does not decrease role and decisive importance of the rocket forces, troops of air defense, ground forces, navy.

The considerable technical progress of aviation equipment and introduction in VVS of rocket weapon sharply increased the combat capabilities of manned aircraft and enlarged the regions of their combat employment.

Engels noted that "... the successes of technology, hardly they became applicable and actually were applied to the military targets, immediately - almost it is forcible, frequently moreover, against military command's will - produced changes and even rolls in the method the conduct of combat"[1].

FOOTNOTE[1]F. Engels. Anti-Duhring, Gospolitizdat, 1952, page 160. ENDFOOTNOTE.

Rapid technical progress touched not only Air Force. In the advanced countries successfully are developed the means of the counteraction to the manned and pilotless air attack weapons.

The development of the new types of weaponry and technology of VVS enriches operational art and tactics of the combat employment of aviation. The most important task of operational art and tactics of VVS is research and mastery/adoption of the new methods of conducting the combat operations on the air and ground (sea) targets under conditions of applying the contemporary combat means.

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Table of the fundamental tactical-technical characteristics of air-to-surface missiles.

(1) № по пор.	(2) Наименование ракеты	(3) Принадлежность	(4) Стартовый вес, кг	(5) Длина, м	(6) Диаметр, м	(7) Размах крыльев, м	(8) Заряд	(9) Двигатель	(10) Дальность действия, км	(11) Скорость полета (число М)	(12) Система наведения	(13) Запуск	(14) Примечание
1	(15) „Зуни"	(16) США	48	2,79	0,13	—	(17) Обычный	РДТТ; 3,16 *т*	9	(18) Около 3М	(19) Неуправляемая	(20) С истребителей и истребителей-бомбардировщиков.	(21) Находится на вооружении
2	(22) „Булпап"	(23) То же	260	3,36	0,3	0,93	(24) Обычный	ЖРД	До 9	2М	(25) Радиокомандная	(26) С самолетов и вертолетов	(23) То же
3	(27) „Хаунд Дог"	„	4500	12,75	0,71	3,63	(28) Ядерный, 4 *Мет*	ТРД; 3,6 *т*	800	1,7М	(29) Автономная	(30) С бомбардировщиков	„
4	(31) „Скайболт"	„	•	7,5	•	—	(28) Ядерный, 2 *Мет*	2 РДТТ	2400	9М	(29) Автономная	(30) С бомбардировщиков	(32) Баллистическая ракета находится в стадии разработки
5	(33) „Блю Стил"	(34) Англия	6800	10,5	1,27	3,9	(28) Ядерный, 4 *Мет*	ЖРД; 9 *т*	540	2М	(29) Автономная	(30) С бомбардировщиков	(25) Находится в производстве
6	(36) „Норд"	(37) Франция	144	2,55	0,25	0,78	(24) Обычный	РДТТ	5,4	1,7М	(25) Радиокомандная	—	(25) То же

Key: (1). No on pores. (2). Designation of rocket. (3). Accessory/affiliation. (4). Launching weight, kg. (5). Length, m. (6). Diameter, m. (7). Span of wings, m. (8). Charge. (9). Engine. (10). Range, km. (11). Flight speed (Mach number). (12). Guidance system. (13). Starting/launching. (14). Note. (15). "Zuni". (16). USA. (17). Usual. (18). About. (19). Not guided. (20). From fighters and fighter-bombers. (21). It is located as arms. (22). "Bullpup".

(23). The same. (24). Usual. (25). Radio-command. (26). From aircraft and helicopters. (27). "Hound Dog". (28). Nuclear, ...Mt. (29). Autonomous. (30). From bombers. (31). "Skybolt". (32). Ballistic missile is located in stage of development. (33). "Blue Steel". (34). England. (35). It is in production. (36). "Nord". (37). France.

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Table of the fundamental tactical-technical characteristics of air-to-air missiles.

(1) № по пор.	(2) Наименование ракеты	(3) Принадлежность	(4) Стартовый вес, кг	(5) Длина, м	(6) Диаметр, м	(7) Размах крыльев, м	(8) Заряд	(9) Двигатель	(10) Дальность действия, км	(11) Высота боевого применения, км	(12) Скорость полета (число М)	(13) Система наведения	(14) Запуск	(15) Примечание
1	(16) „Фолкон"	(17) США	55	2	0,16	0,5	(18) Обычный	РДТТ	8	(19) До 22	(19) До 3М	(20) Полуактивная радиолокационная или тепловая	(21) С истребителей	(22) Находится на вооружении
2	(23) „Сайдуиндер"	(24) То же	70	2,87	0,12	0,5	(24) То же	РДТТ	3,5	(25) Более 15	2,5М (26)	Тепловая	(24) То же	(24) То же
3 (27)	„Спарроу-III"	„	173	3,65	0,22	1	„	РДТТ	10	(25) Более 15	2,5—3М	(28) Радиолокационная	„	„
4 (29)	„Джини"	„	408	2,92	0,44	—	(30) Ядерный	РДТТ	4,5	(25) Более 15	3М	(24) Неуправляемая	(32) С истребителей и бомбардировщиков	„
5	(33) „Файрстрик"	(34) Англия	136	3,17	0,22	0,74	(35) Обычный	2 РДТТ	7	•	(35) Более 2М	(24) Тепловая	С истребителей	„
6	„Матра" (36)	(37) Франция	180	3,10	0,26	1	(24) То же	2 РДТТ	7	17,5	1,8М	(33) Полуактивная радиолокационная	(21) телей (24) То же	„

Key: (1). Sequence nc. (2). Designation of rocket. (3). Accessory/affiliation. (4). Launching weight, kg. (5). Length, m. (6). Diameter, m. (7). Span of wings, m. (8). Charge. (9). Engine. (10). Range, km. (11). Combat altitude, km. (12). Flight speed (Mach number). (13). Guidance system (14). Starting/launching. (15). Note. (16). "Falcon". (17). USA. (18). Usual. (19). To. (20). Semi-active radar or thermal. (21). From fighters. (22). It is located as arms. (23). "Sidewinder". (24). The same. (25). It is more. (26). Thermal.

(27). "Sparrow-III". (28). Radar. (29). "Genie". (30). Nuclear. (31). Not guided. (32). From fighters and bombers. (33). "Firestreak". (34). England. (35). Usual. (36). "Matra". (37). France. (38). Semi-active radar.

Designations: ZhRD - liquid propellant rocket engine; RDTT - solid propellant rocket engine; TRD - turbojet engine; • - no data.

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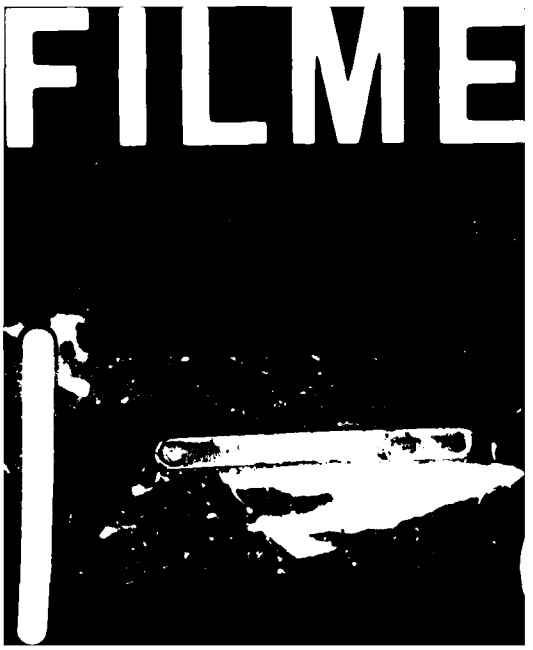
FILME